Expert Report Related to the Crossflow Ultrasonic Flow Measurement Device

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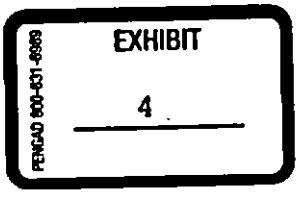
July 19, 2010



EXPERT REPORT RELATED TO THE CROSSFLOW ULTRASONIC FLOW MEASUREMENT DEVICE

by: THOMAS MARTIN, P.E.; JARED WERMIEL, P.E.; and JAMES LIEBERMAN

Executive Summary

We are three former senior managers of the U. S. Nuclear Regulatory Commission (NRC) with over 75 combined years of nuclear regulatory experience. We have been asked by counsel for Caldon, Inc. (Caldon) to evaluate the completeness and accuracy of communications between Westinghouse and the NRC concerning Westinghouse's Topical Report CENPD-397-P, Revision-01-P "Improved Flow Measurement Accuracy Using Crossflow Ultrasonic Flow Measurement Technology" and to prepare a report describing our opinions and conclusions. To focus our efforts, counsel asked that we address several questions, as described in our report.

In 1999 ABB Combustion Engineering Nuclear Power, Inc. (the predecessor of Westinghouse)[1] submitted to the NRC for approval a Topical Report that provided the technical basis for a device, called the Crossflow ultrasonic flow meter (Crossflow or Crossflow UFM). This device was developed by the Advance Measurement and Analysis Group (AMAG) and marketed by Westinghouse. It may also be referred to as the AMAG Crossflow UFM. It was claimed that this device could measure feedwater flow rate with such high accuracy that the operators of nuclear plants would be able to use this device to justify raising the power level of their reactors by about 1.5%, which would provide a significant economic benefit. This was important to the NRC because feedwater flow rate is used to determine reactor power level, an input to the plant safety analysis and part of the plant license.

As background, Topical Reports are reports that are voluntarily submitted to the NRC by industry organizations, such as Westinghouse, related to technology or services that will likely be referenced in multiple licensing actions. The NRC approval of a Topical Report permits the use of the approved technology generically in multiple licensing reviews without additional review by the NRC. Once Topical Reports are approved by the NRC that approval becomes a precedent that can be subsequently referenced either in future licensing actions or safety analyses by licensees, thus avoiding potentially lengthy and difficult repetitive technical reviews by the NRC. Based on our review of internal Westinghouse documents produced in discovery, documents and statements that were provided to the NRC staff by Westinghouse and its predecessor for the Crossflow UFM, and our knowledge of the NRC regulatory requirements that apply specifically to the use of Crossflow in nuclear power plants, we have concluded that Westinghouse and its predecessor engaged in a deliberate and continuing pattern of withholding important information concerning the accuracy and the performance of Crossflow from the NRC staff during the period from 1999 until mid 2007, the time period of our review. That

[1] British Nuclear Fuels Limited (BNFL) acquired ABB Combustion Engineering Nuclear Power, Inc. in 2000 and merged it into Westinghouse Electric Company. This report uses the term "Westinghouse" to refer to ABB and its successor companies.

information was material to NRC decisions about the use of Crossflow by NRC licensees in nuclear power plants.

The NRC approved the Crossflow Topical Report in 2000 based on technical claims that Westinghouse was not able to substantiate or verify. Shortly after approval of this Topical Report, the Crossflow technology began to be used broadly in the nuclear industry as the basis to justify the operation of nuclear power plants at higher power levels. Subsequently, it became evident to the NRC that significant problems existed with the Crossflow system as a result of several operating events in 2003. It was discovered that some nuclear power plants were actually operating for extended periods of time above their licensed power levels as a result of their reliance on Crossflow.

A significant part of the Crossflow Topical Report was a representation that Westinghouse had a valid scientific basis for the claim that it could measure feedwater flow within 0.5%. In fact, at the time of submission of the Topical Report, Westinghouse had knowledge that the basis for this claim lacked validity. As time went on, Westinghouse attempted to support their original accuracy claims with knowledge from operating experience and other tests and analyses. Rather than providing evidence to support its claimed accuracy, this additional information provided further evidence to Westinghouse that it lacked a valid technical basis for the Crossflow accuracy claim. Yet, Westinghouse never disclosed to the NRC the full extent of its knowledge, and it continued to minimize the significance of the adverse information and persisted in its claim to the NRC that Crossflow was performing as stated in the Topical Report.

As described in detail in the body of this report and its attachments, Westinghouse embarked on a course of action that was intended to obtain NRC staff approval of a Topical Report without fully identifying material information that raised technical questions about accuracy of Crossflow. It then deliberately withheld material information over a period of several years that delayed and frustrated NRC's actions to withdraw its approval of the Topical Report. The problems with the Crossflow meters were not isolated to a single assumption or a single faulty test that attempted to justify the Crossflow accuracy. The problems involved several aspects of the technical basis for the accuracy claim. Despite ample evidence that the technical basis for the Crossflow accuracy claims were erroneous and a clear and broad understanding of this within Westinghouse, Westinghouse continued to claim to the NRC staff that the Crossflow technology was sound. At the same time, its confirmatory testing and analysis continued to show that the original technical basis provided in the Topical Report for its accuracy claims could not be justified. Documentation we have reviewed shows that within Westinghouse individuals from the staff engineer level to the senior vice president level were expressing concerns about this problem.

The NRC staff ultimately withdrew its approval of the Topical Report in September 2007, even as Westinghouse continued to feign ignorance to the NRC of the problems with Crossflow that its personnel were acknowledging to each other internally. This pattern of deliberately withholding from the NRC staff information that was material to the NRC's staff reviews raises a serious question about the integrity and trustworthiness of the Westinghouse engineering organization and management and, in particular, the key individuals involved in the decisions to withhold such information. Our review of the documents in this case raises a question that goes beyond the communications related to Crossflow at issue here. It puts into question other

Westinghouse's submittals on licensing matters to the NRC, as well as submittals to the NRC from licensees who rely on Westinghouse's engineering analyses and designs. Based on our collective experience, we are not aware of any other example where approval of a Topical Report was obtained and maintained based on the willful submission of inaccurate and incomplete information, as was demonstrated here.

Following the disapproval of the Crossflow Topical Report the NRC issued a Regulatory Issue Summary (RIS) that provided to reactor licensees the reasons why the NRC disapproved the Topical Report. The RIS did not require a response to the NRC and requested that licensees review this information for applicability to their facilities and consider actions, as appropriate, to assure that their plants operate in accordance with their licensing bases. It is our overall view that Westinghouse's communications with the NRC regarding Crossflow were grossly inadequate to meet the needs of the NRC regulatory process and repeatedly violated 10 CFR 50.5, the NRC Rule on Deliberate Misconduct. The NRC regulatory process to a large degree is an audit process. It is dependent on licensees and its contractors providing complete and accurate information to the NRC and its licensees.

It is our opinion that if the NRC staff had been aware of the information available to Westinghouse at the time of the review of the Topical Report, it would not have approved the Topical Report and would have sought to have it withdrawn by Westinghouse until it could demonstrate a valid technical basis for the accuracy claim. Additionally, it is our opinion that if Westinghouse had conveyed its concerns expressed internally about the technical basis for the accuracy of the Crossflow UFM to the NRC rather than continuing to express confidence in this device, the NRC would have withdrawn its approval much sooner than September 2007, and the staff would have issued a generic communication requiring specific actions by licensees using Crossflow rather than issuing a RIS. These actions would have included immediate removal of the Crossflow meters from service or a plant-specific justification from the users for their continued use in determining reactor power level. Furthermore, based on our direct experience in this type of matter, there is no question in our view that the actions of Westinghouse described herein should be the subject of a wrongdoing investigation by the NRC Office of Investigations (OI). Because of the willfulness involved, we believe that the results of this type of OI investigation would likely have resulted in not only a significant NRC regulatory enforcement action directed to Westinghouse but also a referral by OI to the Department of Justice for potential criminal prosecution.

Finally, we note that there are a large number of documents in this case and referenced in this report. We recognize that additional relevant documents may be identified. Should such documents come to our attention, we reserve the right to either supplement or modify this report.

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I. Introduction

We have been asked by counsel for Caldon, Inc. (Caldon) to prepare a report describing our opinions regarding the completeness and accuracy of communications between Westinghouse and the United States Nuclear Regulatory Commission (NRC) concerning Westinghouse's Topical Report CENPD-397-P, Revision-01-P, "Improved Flow Measurement Accuracy Using Crossflow Ultrasonic Flow Measurement Technology."[2] To focus our efforts, counsel has asked that we address the following questions:

1) **What is the regulatory process for using ultrasonic flow meters for optimizing nuclear reactor output?**

2) **How are Topical Reports used in the nuclear industry?**

3) **What is the history of the use of ultrasonic flow meters Topical Reports for reactor power optimization?**

4) **What is the benefit to Licensees of Westinghouse having an approved Topical Report for the Crossflow Ultrasonic Flow Meter?**

5) **Under NRC regulations what obligations did Westinghouse have to submit complete and accurate information concerning its Topical Report for the Crossflow Ultrasonic Flow Meter?**

6) **Are there any NRC requirements that address the deliberate failure to provide complete and accurate information? Would they be applicable to Westinghouse if it learned that information submitted to the NRC concerning its Topical Report for the Crossflow Ultrasonic Flow Meter was inaccurate or incomplete?**

7) **Did Westinghouse comply with its obligation to provide complete and accurate information to the NRC in all material respects? If not, what information in the Topical Report was inaccurate and incomplete in material respects and did Westinghouse have knowledge that the information was incomplete and inaccurate?**

8) **If Westinghouse had reason to know that its statements were inaccurate or incomplete (Question 7), did Westinghouse violate the NRC Rule on deliberate misconduct, 10 CFR 50.5?**

9) **What are your overall views of the significance of Westinghouse communications as to the NRC regulatory process?**

10) **Was Westinghouse's conduct the cause of the long delay in the NRC investigation of the adequacy of the Topical Report and was the timing of the final NRC resolution within Westinghouse's control?**

[2] BFNL acquired ABB Combustion Engineering Nuclear Power, Inc. in 2000 and merged it into Westinghouse Electric Company. The term "Westinghouse" throughout this report refers to Westinghouse as well as its predecessors ABB and CE.

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This report is based on our professional experiences, review of publicly available documents from the records of the NRC, and documents and depositions provided through discovery in this litigation.

II. Qualifications

A. Thomas Martin

I have more than 30 years of experience in the nuclear field, working in operations, engineering, inspection, and overall regulation of nuclear activities with the Nuclear Regulatory Commission, a nuclear licensee, various consulting companies, and the United States Navy.

I have a Bachelor of Science degree in Ocean Engineering from the United States Naval Academy in 1973 and a Master of Engineering Degree in Nuclear Engineering from the University of Virginia in 1980. I am a Professional Nuclear Engineer, holding an active license in the Commonwealth of Pennsylvania.

I am currently a Vice President and a Partner at Talisman International. Before joining Talisman, I worked for the United States Nuclear Regulatory Commission (NRC) where I held the position of Director of the Division of Safety Systems. I retired in 2007 from the NRC with over 23 years of NRC service. My NRC career included reactor safety and security assignments at NRC Headquarters in Rockville and at the NRC Region III Office in Lisle, Illinois. Prior to being promoted into the senior executive service, I held positions as an NRC Headquarters-based inspection team leader and Chief of the Regional Operations Staff in the Office of the Executive Director for Operations. As an NRC senior executive I held positions in Region III, providing oversight of the reactor safety and resident inspector programs; the Office of Research, managing rulemaking and generic safety issues; the Office of Administration, responsible for NRC facilities and internal security; and finally in the Office of Nuclear Reactor Regulation, responsible for systems-related safety evaluations, generic safety issues, and evaluating proposed changes to existing licenses. I was a key member of the NRC Incident Response Team for reactor safety.

I have made presentations to the NRC Commission on safety issues at nuclear facilities. I led numerous NRC Headquarters-based team inspections at operating reactors. I was the lead NRC executive for the development of an NRC-wide excellence plan, chaired a high-level oversight review panel for an operating reactor receiving significant NRC attention, and led the engineering portion of an Independent Safety Assessment at an operating reactor. I was the Director of the NRC Division of Facilities and Security following the September 11, 2001, terrorist event and guided significant changes to NRC security and emergency response programs during this time.

I began my career as an officer in the nuclear navy. Before coming to the NRC, I worked for General Public Utilities at Three Mile Island in support of the post-accident activities and for Pennsylvania Power and Light Company as a construction and quality assurance engineer at the Susquehanna Nuclear Station.

A copy of my resume is attached, see Attachment 1.

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B. Jared Wermiel

I have more than 30 years of experience in nuclear regulatory activities at the NRC as a reviewer, supervisor and manager of activities associated with nuclear power plant safety and support systems in new reactors and operating plants.

I have a Bachelor of Science degree in Chemical Engineering from Drexel University in 1972. I am a licensed Professional Engineer in the State of Maryland.

From 1972 to 1978, I worked for the Bechtel Power Corporation on the design of balance-of-plant and auxiliary systems for several nuclear power plants under construction.

In 1978, I joined the U.S. Nuclear Regulatory Commission as a reviewer in the Auxiliary Systems Branch of the Office of Nuclear Reactor Regulation (NRR). My responsibilities included review of various auxiliary and reactor support systems and design aspects in plants under construction for compliance with applicable NRC licensing criteria. These review areas included cooling water and balance-of-plant systems, fire protection, spent fuel storage and handling, and protection of safety systems from pipe breaks and natural phenomena. I also provided direct support to the recovery of Three Mile Island Unit 2 following the accident there in 1979.

In 1982, I became a section leader in the Plant and Auxiliary Systems Branch, NRR responsible for oversight of a group of engineers involved in reviews of reactor auxiliary and support systems in new plant designs and plants under construction and for criteria development and revision associated with those aspects of nuclear power plant regulation. During this time, I served as an expert witness before the Atomic Safety and Licensing Board on the auxiliary feed water system improvements for restart of Three Mile Island Unit 1 and non-seismic issues for the restart of Diablo Canyon Units 1&2.

In 1990, I became Chief, Human Factors Assessment Branch with responsibility for oversight and management of a group of engineers and professionals involved in the review and criteria development of control room design changes, human-machine interface issues, improvements to operating procedures and other factors affecting operator performance in new plant designs and operating plants.

In 1992, I became Chief, Instrumentation and Controls Branch, NRR with responsibility for oversight and management of a group of engineers involved in review of analog and digital instrumentation and control (I&C) system modifications to operating plants and new plant designs. I oversaw development of the first comprehensive guidance for digital I&C system upgrades to operating plants. I also served as the lead NRR contact for issues involving nuclear power plant response to the Year 2000 Problem.

In 1999, I became Chief, Reactor Systems Branch, NRR responsible for oversight and management of a group of engineers involved in the review and criteria development of reactor safety systems, nuclear fuel design, accident analysis, and all aspects of emergency core cooling in new reactor designs and operating plants.

In 2005, I became Deputy Director of the Division of Safety Systems, NRR with responsibility for management of four branches involved with review and criteria development of reactor

safety systems, containment and ventilation systems, balance-of-plant and reactor auxiliary and support systems, and containment sump improvements.

In 2008, I became Senior Level Advisor on Digital Instrumentation and Control with responsibility for oversight of the development of an improved licensing process for implementation of digital I&C system upgrades to operating plants.

Since retiring from the NRC in April 2009, I have been a consultant on nuclear power plant safety matters.

A copy of my resume is attached, see Attachment 2.

C. James Lieberman

I have more than 30 years of experience in nuclear regulatory activities with more than 20 years experience reviewing NRC inspection, investigation, and enforcement documents associated with activities regulated by the Nuclear Regulatory Commission.

I have a Bachelor of Science degree in Mechanical Engineering from the University of Rhode Island in 1967, a Master of Science degree in Thermal Engineering from Cornell University in 1969, and a Juris Doctor degree from George Washington University in 1974. I am a member of the Bar of the District of Columbia.

Prior to entering law school, I worked at the Eastman Kodak Company and Combustion Engineering Company.

Following law school in 1974, I joined the Office of the General Counsel of the US Atomic Energy Commission[3] working in a variety of legal areas including representing the NRC staff in enforcement proceedings, licensing hearings, and rulemakings such as Generic Environmental Statement on Mixed Oxide Fuel, Table S-3, and Access; providing counsel on inspection, investigation, enforcement, government contracts, personnel, FOIA, and Privacy Act matters; drafting regulations, reviewing regulatory guides, and providing legal assistance during the reorganization from AEC to NRC.

In the spring of 1977, I started counseling the Office of Inspection and Enforcement. In January 1982, I became the Director of the Enforcement Staff of the NRC Office of Inspection and Enforcement responsible for developing and implementing the Commission's enforcement program. In September 1982, I became the Chief Counsel for Regional Operations & Enforcement in the Office of the Executive Legal Director which later merged with the Office of General Counsel whereon I became the Assistant General Counsel for Enforcement. In these positions I was responsible for legal review of all enforcement actions, representation of the NRC staff in enforcement proceedings, counseling on enforcement, inspection, investigation, and regional matters, and supervising the NRC regional counsels.

[3] The Energy Reorganization Act of 1974, as amended, abolished the U.S. Atomic Energy Commission on January 19, 1975 and its regulatory functions were taken over by the NRC.

In April 1987, upon the abolishment of the NRC Office of Inspection and Enforcement, I became the Director of the Office of Enforcement. I managed the Commission's enforcement program and was accountable for all NRC enforcement actions. I developed the Commission's policy statements on enforcement, protection of allegers against retaliation, and safety-conscious work environments; issued enforcement guidance memoranda; approved significant enforcement actions including actions based on reports of the Office of Investigations; and monitored regional enforcement activities. I managed the rulemakings on Completeness and Accuracy of Information (e.g., 10 CFR 50.9) and Deliberate Misconduct (10 CFR 50.5). I chaired agency-wide review teams on discrimination (NUREG-1499) and enforcement (NUREG-1525), both of which resulted in significant changes to NRC programs and policies. Internationally, I advised senior Russian and Ukrainian officials in developing their regulatory and enforcement programs in the civilian nuclear area following the breakup of the Soviet Union.

In August 1999, I became a Special Counsel in the Office of General Counsel serving as the lead NRC counsel for license termination and decommissioning issues; high and low-level waste issues; state agreement program matters; enrichment activities; Fuel Cycle rulemaking, guidance, and licensing actions; West Valley Demonstration Project; and clearance rulemaking.

Since retiring from the NRC in April 2004, I have been a consultant to the nuclear industry and the US Department of Energy. My engagements have involved matters such as high and low-level waste disposal, license decommissioning, reprocessing, import and export of nuclear material, enforcement, and allegation investigation. I have been an expert witness in three arbitration cases involving NRC requirements[4] and assisted in a shareholder derivative suit involving a power reactor. While at the NRC, I appeared as a witness in a number of enforcement actions before NRC adjudicators. I also appeared before the Commission on various regulatory matters.

A copy of my resume is attached, see Attachment 3.

III. Response to Questions and Opinions

1) **What is the regulatory process for using ultrasonic flow meters for optimizing nuclear reactor output?**

A nuclear power plant operating power level is indicated in the plant's operating license. Ultrasonic flow meters (UFMs) provided by either Caldon or Westinghouse have been used to improve the accuracy of feedwater flow rate measurement in nuclear power plants. This improved feedwater flow rate accuracy is used by licensees to more precisely measure the power output of their reactor. This more precise measurement allows them to operate their nuclear power plant at a slightly higher power level in one of two ways. Licensees may either request approval from the NRC in advance for a "measurement uncertainty recapture" (MUR) power

[4] In 2004, I appeared as an expert witness in the arbitration matter of Westinghouse Electric Co., LLC, v. Viacom, Inc., Case No. 16 Y 192 00937 02. In 2005, I appeared as an expert witness in the arbitration matter of Chevron U.S.A., Inc. and Valley Pines Associates v. Combustion Engineering, Inc. In 2006, I appeared as an expert witness in the arbitration matter of General Atomics Energy Services, Inc. v. Honeywell International, Inc., AAA Case No. 51 198Y0059205

uprate or they take advantage of the higher accuracy of the UFM to more precisely calibrate their other instruments for what is referred to by the NRC as "power recovery." MUR uprates require an amendment granted by the NRC to the plant's operating license which allows the operator to increase the licensed power of the reactor by about 1.5%. The general process of modifying a nuclear plant operating license is referred to by the NRC as a "licensing action."

The power recovery method for using a UFM involves a documented safety analysis by the licensee in accordance with NRC regulation 10 CFR 50.59 demonstrating that there is no significant risk involved in using a UFM to calibrate other instruments that would permit the plant to operate at a higher power level yet stay within the current licensed power level. The power recovery method takes advantage of the fact that the venturi flow instrument normally used to measure feedwater flow and used as an input to calculate thermal reactor power output, becomes slightly fouled (dirty) over a period of months, and therefore gradually indicates flow at a slightly higher value than actual. The effect of this fouling makes it appear that the reactor power is increasing slightly, causing the plant operators to compensate by slightly decreasing the actual power level. Using a UFM for ongoing calibration of the venturi instruments avoids the need for the operators to make this compensating downward adjustment, therefore permitting the reactor to operate at a higher power level over the course of an operating cycle (usually about 2 years) until the flow measuring venturi is cleaned and the effects of the fouling are removed. The use of a UFM for power recovery would likely result in less than half the increase in overall power permitted by an MUR. The power recovery method does not require pre-approval from the NRC.

2) **How are Topical Reports used in the nuclear industry?**

Topical Reports may be submitted to the NRC by industry organizations, such as an equipment vendor or an owners group. The Topical Report may be submitted on their own choice or in response to a request of the NRC staff, on specific safety-related subjects. In these latter cases, this would permit the NRC staff to review the safety issue independently of or concurrently with an operating license review. The purpose of the NRC program to review and approve Topical Reports is to minimize industry and NRC time and effort by providing for a streamlined generic review and approval of the safety-related subject with subsequent referencing in plant-specific licensing actions, rather than repeated reviews of the same subject. Once Topical Reports are approved by the NRC, that approval becomes a precedent that can be subsequently referenced either in future licensing actions or in safety analyses by licensees, thus avoiding potentially lengthy and repetitive technical reviews by the NRC staff.

Below are excerpts from the NRC references describing the use of Topical Reports:

> **Regulatory Issue Summary 2002-08, Availability of the Topical Report Program Description and Status of Staff Reviews on the NRC Web Site, May 22, 2002**
>
> Under the NRC's Topical Report program, a licensee or industry organization may, on its own initiative or at the request of the NRC staff, submit Topical Reports on specific safety-related topics independent of any construction permit or operating license review. The purpose of the program is to minimize the time and effort required of both the industry and the NRC by allowing a single review and approval of the safety-related topic, rather than repetitive reviews of the same topic.

Lic-101, License Amendment Review Procedures, Rev 2, Effective December 12, 2002

Referencing Topical Reports in license amendment applications and associated NRC [Safety Evaluations] improves the efficiency of the licensing process by allowing the staff to coordinate the review of a methodology or proposal that will be used by multiple licensees.

NRR Office Instruction LIC-500, Revision 3, Processing Requests for Reviews of Topical Reports, June 24, 2005

Topical reports improve the efficiency of the licensing process by allowing the staff to review a proposed methodology, design, operational mode, or other safety-related subjects that will be used by multiple licensees following approval by referencing the approved Topical Report. The Topical Report provides the technical basis for a licensing action.

Under the NRC Topical Report program, industry organizations, such as a vendor or an owners group, may on their own choice or at the request of the NRC staff, submit reports to the NRC on specific safety-related subjects and have them reviewed independently of any operating license review. The purpose of the program is to minimize industry and NRC time and effort by providing for a streamlined review and approval of the safety-related subject with subsequent referencing in licensing actions, rather than repeated reviews of the same subject.

During the timeframe of the review and approval of the Topical Reports for the feedwater flow ultrasonic measuring devices, it was the policy of the Office of Nuclear Reactor Regulation (NRR) to maximize the use of Topical Reports for the review of licensing actions that may be generic, that is, licensing actions that involve more than one plant. NRR would discourage the review of potentially generic license amendment changes until a Topical Report had been approved. The intent of this policy was to maximize the efficiency of the NRC staff conducting the licensing reviews and improve the overall timeliness of the reviews. Additionally, NRC's approval of a Topical Report could be relied upon by licensees conducting their own safety reviews for the power recovery method of using a UFM. Unless there was some obvious issue or anomaly, NRC inspectors would not question a licensee's safety analysis that was based on an NRC approved Topical Report.

Therefore an NRC approved Topical Report for the use of a UFM was essential for vendors in the marketing of their systems as it gave potential customers a reasonable expectation of prompt regulatory approval, in the case of an MUR uprate, or NRC acceptance in the case of use of UFM for power recovery. Conversely, the NRC would likely not have approved MUR uprates, and it is unlikely that licensees would have relied on these UFM instruments for power recovery, unless a Topical Report was already approved by the NRC.

3) <u>What is the history of the use of ultrasonic flow meters Topical Reports for reactor power optimization?</u>

In the late 1990's several licensees informed the NRC of their plans for using improved flow measurement technology in their plants and their intentions to request credit from the NRC for

these improvements in power uprate license submittals. During this time Topical Report No. ER-80P, "Improving Thermal Power Accuracy and Plant Safety While Increasing Operating Power Level Using the LEFM System," prepared by Caldon, Inc, was submitted to the NRC as the basis for an MUR uprate by the Texas Utilities Electric Company (TUE). The NRC approval of this Topical Report as part of this MUR amendment request would provide the precedent for subsequent requests.

Regarding the generic use of the Caldon UFM, as stated in an NRC memorandum from the Executive Director of Operations of the NRC to the NRC Commissioners (Secy-98-235, dated October 9, 1998):

> On July 14, 1998, the staff met with representatives of TUE to discuss licensing submittals for a proposed power uprate license amendment. Also present at the meeting were representatives of Caldon and six other licensees (Arizona Public Service, Commonwealth Edison, Florida Power & Light, Niagara Mohawk, Northern States Power, and Tennessee Valley Authority). Based upon the attendance at this meeting, the staff believes that there is a high likelihood of additional exemption requests being submitted if the TUE exemption request and power uprate are approved. **If the staff concludes that the Caldon Topical Report is acceptable** (emphasis added), the staff believes that a rulemaking should be instituted to change Appendix K in order to avoid the need to issue repetitive exemptions.

It should be noted that the change to 10 CFR Part 50, Appendix K, of the NRC regulations, referred to above, was intended to facilitate the process of granting MUR uprates.

On September 30, 1999, the staff issued a license amendment to the Comanche Peak Steam Electric Station (CPSES), Unit 2, operated by the Texas Utilities Company that increased the rated thermal power by 1 percent. CPSES requested this change due to its use of an upgraded feedwater flow measuring system - the leading edge flow meter (LEFM) made by Caldon, Inc.

Regarding the generic use of the Crossflow UFM, as stated in a memorandum to the NRC Commissioners (Secy-00-0076, dated March 30, 2000):

> On March 20, 2000, the staff issued the safety evaluation for CENPD-397-P, Revision-01-P, "Improved Flow Measurement Accuracy Using Crossflow Ultrasonic Flow Measurement Technology." **Approval of this report for referencing in license applications will allow a licensee to use the increased accuracy of the Crossflow flow meter** (emphasis added) to support a reduction in the power level margin used in the plant emergency core cooling system (ECCS) evaluation. The licensee may then seek a license amendment to operate the power plant at higher power levels. This power level margin is 2 percent of the licensed reactor power and is required by the Code of Federal Regulations, 10 CFR Part 50, Appendix K, "ECCS Evaluation Model," to account for power measurement uncertainty.

4) **<u>What is the benefit to Licensees of Westinghouse having an approved Topical Report for the Crossflow Ultrasonic Flow Meter?</u>**

The benefit to licensees was the assurance that a license amendment for a MUR uprate that referenced an approved Topical Report would be approved by the NRC or that a licensee's power

recovery safety analysis would not be challenged by a NRC inspector. As discussed earlier in the response to question 2, during the timeframe of the review and approval of the Topical Reports for the feedwater flow ultrasonic measuring devices, it was the policy of the NRC's Office of Nuclear Reactor Regulation (NRR) to maximize the use of Topical Reports for the review of licensing actions that may be generic, that is, involve more than one plant. NRR would discourage the review of potentially generic license amendment changes until a Topical Report had been approved. The intent of this policy was to maximize the efficiency of the NRC staff conducting the licensing reviews and improve the overall timeliness of the reviews. Additionally, NRC approval of a Topical Report could be relied upon by licensees conducting their own safety reviews for the power recovery method of using UFM. Unless there was some obvious issue or anomaly, NRC inspectors would not question a licensee's safety analysis that was based on an NRC approved Topical Report.

Therefore, an NRC approved Topical Report for the use of UFM was essential for vendors in the marketing of their systems as it gave licensees, Westinghouse's potential customers, a very high expectation of prompt regulatory approval, in the case of an MUR uprate, or NRC acceptance in the case of use of UFM for power recovery.

Once the NRC had suspended its prior approval of the Westinghouse Topical Report for the Crossflow device, the staff informed Westinghouse on September 26, 2007 (MLO71650263) that it would not approve any current or future license amendment request for measurement uncertainty recapture power uprates using the Crossflow UFM that relied on the CENPD-397-P-A Topical Report. The next day, NRC issued a letter to Fort Calhoun noting that they were not approving their license amendment because of the withdrawal of the NRC's approval of the Topical Report. The NRC staff then issued a Notice of Denial of Amendment to Omaha Public Power District and published a Federal Register Notice of the denial (ML072540833).

5) **Under NRC regulations what obligations did Westinghouse have to submit complete and accurate information concerning its Topical Report for the Crossflow Ultrasonic Flow Meter?**

Westinghouse has an obligation to provide complete and accurate information in all material respects to the NRC and is subject to sanction if it deliberately provides materially inaccurate and incomplete information.

In considering the answer this question, it is important to understand the requirements of the NRC as they pertain to providing the agency complete and accurate information. The statutory authority for the requirement for complete and accurate information is found in the various licensing provisions of the Atomic Energy Act of 1954, as amended, (AEA) and sections 161, 182, 186, and 274 of the AEA. These authorities focus on licensees.

The NRC has long placed emphasis on the need to provide it with complete and accurate information. The NRC has said:

> [A]ccuracy and forthrightness in communications to the NRC by licensees and applicants for licenses are essential if the NRC is to fulfill its responsibilities to ensure that utilization of radioactive material and the operation of nuclear facilities are consistent with the health and safety of the public and the common defense and security.

Final Rule: Completeness and Accuracy of Information, 52 FR 49362 (December 31, 1987).

Since Westinghouse holds a number of licenses from the NRC and is therefore a licensee, we are confident that it is fully aware of the NRC's expectation and requirements for forthrightness in communications with the NRC for regulatory decisions, e.g., 10 CFR 30.9, 40.9, 50.9, 52.6, and 70.9. In fact, Westinghouse currently has an approved NRC design certification for the AP 1000 and NRC is currently reviewing an amendment to the AP 1000 certified design.[5] Both of these Westinghouse advanced reactor designs reference Topical Reports as a basis to support NRC approval. Because of the ongoing licensing activities and the long history NRC staff has had with Westinghouse in the past, we are highly confident that Westinghouse managers are well aware of the NRC expectations and requirements and also know that NRC will be relying on other information provided by Westinghouse to obtain NRC regulatory approval for other Topical Reports. While NRC holds licensees accountable, it also hold individuals, vendors, and contractors accountable for false or misleading information and has issued orders barring such persons either directly to such persons or to the involved licensee barring persons from participating in NRC licensed activities when there is evidence of false records or misleading statements.

While Westinghouse was a vendor or contractor and not a licensee for the purposes of the Topical Report in question, it knew that its Topical Report was an integral part of the NRC licensing reviews such that any information submitted to the NRC needed to be complete and accurate. The actions of contractors may subject licensees to enforcement actions as NRC holds licensees responsible for the actions of its contractors.[6] Thus, a vendor's or contractor's actions related to inaccurate information can form the basis for enforcement action against the licensee.[7] Such actions can indirectly impact the vendor or contractor. However, NRC also takes actions against contractors, vendor or individuals who deliberately provided incomplete or inaccurate information.[8]

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[5] Westinghouse, as an applicant for approval of its standard reactor design (AP-1000) is also subject to the completeness and accuracy requirements of 10 CFR 52.6. Under 10 CFR 52.6 Westinghouse representations in that application that references Topical Report CENPD-397 must be complete and accurate.

[6] "Generally, the NRC holds licensees responsible for maintaining control and oversight of their contractor and subcontractor activities. As such, in cases involving licensee contractors and subcontractors, the NRC will typically take enforcement action against a licensee for violations arising out of the acts of its contractor or subcontractor." Section VII.B.5 of the NRC Enforcement Policy; Section 5.1.4 of the NRC Enforcement Manual. See, Exelon Generation Company, LLC (EA-08-298) January 6, 2009 (holding licensee responsible for acts of a contractor), 2009 WL 75961.

[7] If a licensee relies on a Topical Report that is inaccurate or incomplete in a material respect by using it in either seeking to take advantage of a power recovery based on a 10 CFR 50.59 analyses or submitting a license amendment to the NRC for a power uprate, the licensee has violated 10 CFR 50.9(a) and is subject to enforcement action. In our view, Westinghouse has an obligation to its customers to submit complete and accurate information to the Commission to avoid NRC taking enforcement action against its customers for violating 10 CFR 50.9.

[8] Final Rule: Revisions to Procedures to Issue Orders; Deliberate Misconduct by Unlicensed Persons, 56 FR 40664, 40665 (August 15, 1991). See, In the Matter of Five Star Products, Inc, Construction Products Research, Inc., and H. Nash Babcock (IA 95-058) (1995) 1995 WL 880729.

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The obligation for providing NRC complete and accurate information was established by the Commission in the case of Virginia Electric and Power Company (North Anna Power Station, Units 1 and 2) CLI-76-22, 4 NRC 480 (1976), affirmed 571 F2d 1289(4th cir. 1978)(VEPCO). The VEPCO case involved a material false statement under section 186 of the AEA based on a licensee unknowingly submitting inaccurate information to the NRC which was material. The licensee statements were based on information obtained from its contractors and thought to be true. The licensee argued in that case that it should be liable for a violation only if it knew the information was false and that materiality requires an element of reliance by the agency. The NRC disagreed holding that knowledge of falsity is not necessary for liability under section 186 of the AEA. The Commission stated in the VEPCO case: "forgiving innocent mistakes puts a premium on innocence." 4 NRC at 386. The Commission further stated that it requires a regime where there is "every incentive to scrutinize internal procedures to be sure as they possibly can be that all submissions to this Commission are accurate." Id.

The Commission also stated that materiality should be judged by "whether a statement is capable of influencing a decision maker, not whether the statement would, in fact, have been relied on." Id. at 487. In practice, materiality is judged by whether a reasonable staff member should consider the information in question in doing his or her job. Consequently, a licensee submitting information from a contractor that is inaccurate in a material respect has submitted a material false statement under VEPCO.

Following several years of taking enforcement actions based on material false statements, the NRC, as a result of the controversy over the use of the term "material false statements" for unintentional inaccurate communications, promulgated regulations addressing the obligation to submit complete and accurate information. These regulations, found in 10 CFR 50.9 and the other licensing parts of the Commission's regulations, codify the licensee's obligations under VEPCO without using the label of "material false statements" for non-intentional inaccuracies. The term "material false statement" was reserved for communication involving willfulness.[9]

10 CFR 50.9 (a) requires that

> Information provided to the Commission by an applicant for a license or by a licensee or information required by statute or by the Commission's regulations, orders, or license conditions to be maintained by the applicant or the licensee shall be complete and accurate in all material respects.

Materiality continues to be judged under the VEPCO standard. It is noteworthy, that not only is materially incorrect information covered by the rule, but omitted information which causes an affirmative statement to be materially incomplete or inaccurate is also actionable under the rule. 52 FR at 49366. Thus, it is a violation of NRC requirements to provide incomplete information on material matter such that the NRC is mislead by the affirmative statement.

10 CFR 50.9(a) continues the obligation set out in the VEPCO decision that

[9] NRC defines willfulness as including careless disregard and deliberateness.

> [A]ny information provided to the Commission or maintained in records required by the Commission which has the ability to influence the agency in the conduct of its regulatory responsibilities must be complete and accurate. 52 FR at 49366.

Importantly, as discussed more fully in response to Question 6, Westinghouse as a contractor to licensees is directly subject to 10 CFR 50.5 that prohibits a person from deliberately providing inaccurate information to either the NRC or its licensees. This creates a clear legal obligation for Westinghouse not to deliberately provide NRC with inaccurate or incomplete information or to deliberately withhold information on material matters. Moreover, each separate communication where Westinghouse deliberately provides NRC with inaccurate or incomplete information or deliberately withholds information on material matters is a separate violation that could subject Westinghouse to enforcement action.

Under both 10 CFR 50.5 and 50.9, the submission of incomplete information is actionable. These regulations would be violated if a submittal states a proposition is supported by Test A when the submitter is also aware of a Test B that does not support the proposition unless there is a justifiable basis for concluding that Test B is not valid. The violation occurs because the affirmative statement about Test A is incomplete because it does not include material information about Test B that NRC needs to be aware of so it can properly evaluate the proposition that Test A supports. By providing information only about Test A, NRC is mislead in thinking that there is no question about the proposition when in fact there is as a result of Test B.

6) **Are there any NRC requirements that address the deliberate failure to provide complete and accurate information? Would they be applicable to Westinghouse if it learned that information submitted to the NRC concerning its Topical Report for the Crossflow Ultrasonic Flow Meter was inaccurate or incomplete?**

Yes. As noted above in response to Question 5, NRC's Rule on Deliberate Misconduct, 10 CFR 50.5, is applicable to Westinghouse and it subjects Westinghouse to sanctions if it deliberately provides inaccurate and incomplete information to the NRC.

Prior to 1991, NRC enforcement actions were generally directed against licensees. Even enforcement actions concerning contractors who have willfully caused violations of Commission requirements or otherwise have engaged in willful misconduct in connection with licensed activities were directed against licensees. Final Rule: Revisions to Procedures to Issue Orders; Deliberate Misconduct by Unlicensed Persons, 56 FR 40664, 40665 (August 15, 1991). However, as noted above in response to Question 5, enforcement actions against licensees could indirectly impact contractors for causing the underlying violations.

In August 1991, NRC promulgated 10 CFR 50.5, the Rule on Deliberate Misconduct. The rule provides:

> (a) Any licensee, applicant for a license, employee of a licensee or applicant; or any contractor (including a supplier or consultant), subcontractor, employee of a contractor or subcontractor of any licensee or applicant for a license, who knowingly provides to any licensee, applicant, contractor, or subcontractor, any components, equipment, materials,

> or other goods or services that relate to a licensee's or applicant's activities in this part, may not:
>
> (1) Engage in deliberate misconduct that causes or would have caused, if not detected, a licensee or applicant to be in violation of any rule, regulation, or order; or any term, condition, or limitation of any license issued by the Commission; or
>
> (2) Deliberately submit to the NRC, a licensee, an applicant, or a licensee's or applicant's contractor or subcontractor, information that the person submitting the information knows to be incomplete or inaccurate in some respect material to the NRC.
>
> (b) A person who violates paragraph (a)(1) or (a)(2) of this section may be subject to enforcement action in accordance with the procedures in 10 CFR Part 2, Subpart B.
>
> (c) For the purposes of paragraph (a)(1) of this section, deliberate misconduct by a person means an intentional act or omission that the person knows:
>
> (1) Would cause a licensee or applicant to be in violation of any rule, regulation, or order; or any term, condition, or limitation, of any license issued by the Commission; or
>
> (2) Constitutes a violation of a requirement, procedure, instruction, contract, purchase order, or policy of a licensee, applicant, contractor, or subcontractor.

This rule places contractors on notice that they may be subject to enforcement action for deliberate misconduct that causes, or but for detection, would have caused a licensee to be in violation of any of the Commission's requirements, or for deliberately providing to the NRC, a licensee, or contractor, information which is incomplete or inaccurate and in some respect material to the NRC. The rule reaches persons who knowingly supply or provide goods or services that relate to activities subject to NRC regulations. As stated in the Statement of Consideration:

> ... the Commission would conclude that a person knows a product relates to NRC regulated activities if the equipment or service supplied or provided affects structural supports, control systems, electrical generation, steam supplies, fluid boundary and similar activities where a reasonable person would recognize that there is a potential for safety significance. Thus, a person providing such things as piping, electrical equipment, chemicals, computer services, consulting services, and welding services to be performed at or delivered to a nuclear power plant would meet the test. Clearly, if the purchase order is subject to part 21 or appendix B of part 50 a person supplying the product would be covered.
>
> 55 FR at 40679.

The NRC provided a number of examples of the application of this rule. Relevant examples included:

> ... companies that provide testing services and whose employees deliberately supply false data to a licensee in an effort to convince the licensee that the product meets 10 CFR part 50, appendix B; vendors whose deliberate false certification causes a licensee to acquire components that do not meet license requirements, such as the ASME code, where required; and companies that supply components or other items knowing that the certificates of compliance are false. In these cases, depending on the circumstances, an order might be issued to the contractor or vendor, prohibiting use of a service, product, or component in licensed activities, or to the employee who had deliberately committed the misconduct, prohibiting that employee's involvement in licensed activities.
>
> 55 FR at 40680.

The Commission further stated in response to a comment that the rule should only apply to matters significantly affecting public health and safety, that "deliberate misconduct, by itself, raises a significant public health and safety concern." 55 FR at 40675-6.

In submitting a Topical Report for NRC approval that was intended for use by reactor licensees and, in fact, was used by licensees in submittals for license amendments, Westinghouse placed itself squarely within the prohibition against deliberate misconduct. From the language in the Statement of Consideration it is clear that the Commission considers deliberate misconduct to be serious even when only one licensee is impacted. It is even more significant when the actions impact multiple licensees. This was demonstrated in the case of Thermal Science, Inc. (EA95-009) (TSI) where the NRC issued a $900,000 civil penalty in 1996 for a series of violations of 10 CFR 50.5. [10] In that enforcement action, NRC described section 50.5 as "prohibit[ing] a contractor of a NRC licensee from deliberately submitting information that the contractor knows to be incomplete or inaccurate in some respect material to the NRC." TSI was a company that manufactured Thermo-Lag fire barrier products and had misrepresented to the NRC the quality and adequacy of Thermo-lag material to meet the fire protection requirements and license conditions of its various customer licensees. NRC concluded that:

> Violations involving multiple instances, in which a vendor deliberately provides inaccurate and/or incomplete information related to the performance and quality of its important-to-safety products, constitute a very significant regulatory concern, are wholly unacceptable, and will not be tolerated. These violations are further aggravated because they were committed in the context of an ongoing NRC investigation into concerns about the quality and performance of Thermo-Lag products with significant implications regarding the compliance of a substantial number of nuclear power plant licensees with the Commission's regulations. These representations were provided after specific concerns were raised by the NRC staff about the nature of the testing that was performed to qualify Thermo-Lag products for use in nuclear power plants. Furthermore, these representations were made to the NRC in an apparent attempt to convince the NRC that impartial, independent test laboratories with no financial interest in Thermo-Lag had

[10] Thermal Science, Inc. EA 95-009 (October 1, 1996) - NUREG-0940 Vol. 18, No. 2 Part 2 "Enforcement Actions: Significant Actions Resolved Reactor Licensees" at page C-10 (ADAMS Number ML003729814) 1996 WL 1808234.

evaluated this product and had confirmed TSI's published claims of Thermo-Lag's fire barrier capabilities.[11]

The Thermal Science case is particularly relevant to this question even though it did not involve a Topical Report. It did involve submittal of reports to the NRC directly by a contractor of numerous licensees who relied upon the information submitted to the NRC by Thermal Science to meet licensing requirements. In addition, to the regulatory enforcement action discussed above, criminal prosecution was also initiated.[12]

10 CFR 50.5 addresses submittals by contractors to obtain NRC approval of their Topical Reports and to respond to NRC questions concerning the continued approval and use of their Topical Reports. Such contractors are prohibited from deliberately providing inaccurate and incomplete information to the NRC. It is also our view, that the NRC would apply this rule to the deliberate failure to correct information that was previously provided, even if the information was not originally submitted knowing it was inaccurate and incomplete. This is because of the long standing NRC position of considering the circumstances of the failure to correct in determining the seriousness of the original violation.[13]

Consequently, it is our opinion that 10 CFR 50.5 is the applicable regulation to address the deliberate failure by a submitter of a Topical Report to provide the NRC complete and accurate information. In addition, it is our opinion that this regulation is directly applicable to Westinghouse when it submitted information to the NRC concerning its Topical Report for the Crossflow Ultrasonic Flow Meter that it knew, as explained in section 9 of this report, was inaccurate and incomplete. Furthermore, Westinghouse contracted with licensees and provided information and equipment directly to them in support of their efforts to increase their reactor power until a decision was made by Westinghouse to halt the sales of Crossflow in February 2004, and even then Westinghouse would have been aware that ongoing amendment requests for use of the Crossflow system as justification to raise reactor power were before the NRC. For example, Calvert Cliffs and Ft. Calhoun submitted applications relying on Crossflow on January 31, 2005, and March 31, 2005, respectively. By supplying these licensees with information that it knew would be considered in the licensing process and equipment to others that was inservice for power recovery and Westinghouse knew was not capable of reliably achieving its advertised accuracy, Westinghouse placed itself within the scope of the deliberate misconduct rule as the rule applies to contractors that cause or would have caused, if not detected, a licensee to be in violation of the conditions of their license, i.e., exceeding the licensed power levels, and/ or deliberately providing licensees with inaccurate and incomplete information in respect to matters material to the NRC.

Violations of 10 CFR 50.5 are also referred to the Department of Justice for consideration of criminal prosecution as willful violations of substantive requirements and are subject to criminal

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[11] Id.

[12] NRC Information Notice 94-86: Legal Actions Against Thermal Science, Inc., Manufacturer of Thermo-Lag (December 22, 1994) (http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/1994/in94086.html).

[13] Section IX of the NRC Enforcement Policy. http://www.nrc.gov/about-nrc/regulatory/enforcement/enforc-pol.pdf

prosecution under 42 USC 2273[14] and in the case of false statements to the NRC under 18 USC 1801. In sum, NRC considers violations of 10 CFR 50.5 to be very serious matters.

7) **Did Westinghouse comply with its obligation to provide complete and accurate information to the NRC in all material respects? If not, what information provided to the NRC was inaccurate and incomplete in material respects and did Westinghouse have knowledge that the information was incomplete and inaccurate?**

No. Westinghouse did not comply with its obligation to provide complete and accurate information to the NRC in all material respects and had knowledge that certain information provided to the NRC was inaccurate and incomplete. Set out below are four sets of statements made by Westinghouse related to the use of the Crossflow ultrasonic feedwater flow measuring device that in our opinion were incomplete and inaccurate, why this information was incomplete and inaccurate, why Westinghouse knew the information was inaccurate and incomplete, and why this information was material to the NRC.

In developing the responses to Questions 7 and 8, we analyzed pertinent documents obtained through the discovery process in this litigation including depositions and associated exhibits, documents obtained from counsel, documents, publically available through the NRC ADAMS system, and our personal knowledge. The documents were given a chronological item number and cross referenced to the "WH" discovery number or the "ML" ADAMS number where applicable. The summary of the documents which includes an excerpt or summary of the each item and its relevancy is provided in two attachments to this report. Attachment 4 to this report provides the document summary organized by the four statements set out below. Attachment 5 to this report provides the document summary organized chronologically by the time frames described in the response to Question 8. The item references in this report correspond to the documents in these attachments.

Statement #1

The Topical Report submitted by Westinghouse in August 1999 at pages 5-9 through 5-11 described an acceptable Crossflow system installation being placed at least 15 pipe diameters downstream of an elbow (flow disturbance) without further justification required based on a presumption of fully developed flow at the installed location. For example, on page 5-9 the simplified equation for the velocity profile correction factor is provided for straight pipe with fully developed flow. On page 5-10 it is stated, "It was observed that at a distance of approximately 15 diameters downstream of the elbow, the velocity profile correction factor became independent of the distance from the elbow." On page 5-11 it is stated that "Equation 5-24 indicates that if the L/D[15] > 14.94 than delta C is less than zero and no correction is required ... ." Further, on page 8-2, it is stated, "It is desirable for the mounting location to be in a straight run of pipe where the flow is fully developed".

[14] 10 CFR 50.111.

[15] L/D refers to the length (L) of straight pipe downstream of a flow disturbance divided by the diameter (D) of the pipe. In other words the instrument would have to be placed in a straight run of pipe approximately 15 diameters downstream of any flow disturbance.

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Westinghouse Knowledge of Inaccuracy and Incompleteness:

Statement 1 was inaccurate because significant examples were found impacting the accuracy of the Crossflow instrument where flow was not fully developed at a location of 15 pipe diameters downstream of the Crossflow installation. It was found that flow variances affecting the accuracy of the Crossflow instrument could occur if the instrument was placed more than 15 diameters downstream of a flow disturbance despite contrary guidance in the Topical Report. Our view that the statement was inaccurate and known to Westinghouse before and after the submittal of the Topical Report is based on documents that are described in section A of Attachment 4. See also our response to Question 8A.

Item 46 is particularly illustrative because it is a November 2005 comprehensive root cause analysis for a reactor overpower event at the Calvert Cliffs station, which concluded, "The root cause of the event was that the design basis document for Crossflow installations (Topical Report) did not consider data indicating that piping/component configuration could produce flow distortions farther downstream than analyzed." Another significant document is Item 24 which recognized in June 2004 that you cannot rely solely on the criteria of 15 or more diameters and points out the inadequacy in the Topical Report. Jaeger, a Principal Engineer at Westinghouse, also stated during his deposition "that there are situations where that 15 L/D criteria is not valid." (Jaeger Deposition at page 94). Other supporting Items are 1-4, 8, 10, 12, 24, 27, 48, 57A, and 64.

Materiality:

Statement 1 was material because the Crossflow instrument depended on fully developed flow so that if a reasonable agency reviewer was aware that fully developed flow could not be achieved at 15 L/D, further questions would have been asked to explore the basis for this assertion in the Topical Report, and the Topical Report would not have been approved with this condition. Additionally, the need to place the Crossflow instrument more than 15 pipe diameters downstream of a flow disturbance, such as a pipe elbow, was a significant assumption to achieve a proper installation which was ultimately shown to be inadequate, and, as shown by the evidence presented above, Westinghouse had ample opportunity to address this issue before the Topical Report was submitted and after the Topical Report was approved by the NRC.

Statement #2

The Topical Report submitted by Westinghouse in August 1999 at page 1-5 states, "Perhaps the most important feature of the Crossflow UFM System is the algorithm used to calculate the Velocity Profile Correction Factor (VPCF)[[16]]. The theoretical bases for this equation which, for fully developed flow, is only a function of Reynolds Number is discussed in Section 2.0 of this report." Further, it is stated at page 2-5, "The close agreement between Equation 2-17 (the Co calculation) and the experimental data over a wide range of Reynolds Numbers provides confidence that the basis for the theoretical equation is well founded."

Westinghouse Knowledge of Inaccuracy:

[16] The Velocity Profile Correction Factor (VPCF) is also referred to as Co (or C subzero).

This statement refers to the confidence that Westinghouse had in determination of the Velocity Profile Correction Factor (VPCF), also referred to as Co (or C subzero), which was critical to the claimed accuracy of Crossflow. Statement 2 was inaccurate because the basis for the algorithm on which Co was founded was faulty and could not be supported. Our view that the statement was inaccurate and known to Westinghouse before and after the submittal of the Topical Report is based on documents described in section B of Attachment 4.

Prior to the submittal of the Topical Report in August 1999, Westinghouse was aware in June 1999 of discrepancies in Crossflow readings between the Byron and Braidwood units despite their feedwater piping configurations being essentially the same and placement of the Crossflow meters at about 30 L/D, locations consistent with the Topical Report guidance. (Item 4A – July 6, 1999; Gurevich deposition, June 14, 2010, page 225; and Item 10- March 26, 2000). It was suspected that pipe roughness may have affected the results. (Item 4A). Pipe roughness was also an issue at SONGS (Item 6-July 7, 1999). There was no indication in the Topical Report that pipe roughness affected the validity of the Co curve.

On June 30 and July 1, 1999, hydraulic tests were run by AMAG at Alden Labs on carbon steel 16" pipe consistent with the type of pipe found at Byron and Braidwood. Those tests were run at the request of Commonwealth Edison, the licensee of the Byron and Braidwood nuclear plants to validate the equations in the Topical Report (Gurevich deposition June 14, 2010, page 237) and presumably to assist in resolving the measurement discrepancies between Byron and Braidwood discussed above. Seven tests were run, but the results were not consistent with the results of the 1996 Alden tests using plastic pipe that were used to derive the C_o curve. In a draft letter dated March 26, 2000 (Item 10) which describes the test results, Chip French stated:

> "A quick review of the data indicates that there are significant differences between the velocity profile correction factor generated using the calculated calibration curve that had previously been produced using plastic pipe and the carbon steel 16" schedule 120 pipe."

In fact, all of the reported results showed significant differences between the velocity profile correction factors derived from the 16" carbon steel pipe tests from the calculated velocity profile correction factor using the calibration curve (Co curve) derived from the 1996 Alden Lab tests. Mr. French attempts in his March 26, 2000 letter to explain away the five worst test results attributing them primarily to signal interference (noise) caused by pipe vibration. French says in his draft letter that AMAG was unprepared to detect noise or to filter out its effects:

> "to correct for these vibrations, one would normally run a spectrum sweep and then insert notch filters to remove the noise. AMAG was not prepared to do this during the Alden [tests], since they did not have an adjustable filter box with them an FM tape recorder to record the ultrasonic signals so that noise could be filtered out after the test."

When asked about the basis for his view that noise interfered with the test, French did not point to any actual evidence of noise and indicated that he would have to rely on AMAG for that information (French deposition, Vol. I, page 34).

Yuri Gurevich, an AMAG engineer who was actively involved in the tests, testified, contrary to French, that he assumed he did conduct a spectrum scan to detect noise prior to conducting the tests and that he does not recall any noise problem with the tests (Gurevich deposition, p. 233). Gurevich also stated in his deposition that the July 1999 test results were very good, he had no recollection of noise that had a substantial affect on the test results, and he disagreed with a statement made by French regarding the limitation of the validity of the test results due to noise (Gurevich deposition, pgs. 244-249). Additionally, the results of the two tests that French considered valid involved differences in the velocity profile correction factor of -0.49% and -0.69%, values that are not consistent with the claimed accuracy of Crossflow. (Item 10 – March 26, 2000). Jaeger also was aware of these test results (Jaeger deposition, pgs. 133 – 134).

French, who was not present during the testing, appeared to reject the five worst test results on the basis of noise created by pipe vibrations without an explanation for why he assumed this, and, if Gurevich, who actually observed the testing and reported the test results to French, is to be believed, his statements strongly indicate that the test results were not affected by noise. (Guervich Deposition June 14, 2010, pages 238-240). Although the 1999 16" carbon steel pipe tests were concluded well before the CROSSFLOW Topical Report was submitted to the NRC, the results were not disclosed to the NRC in the Topical Report (French, Vol. I, page 96). Yuri Gurevich, the AMAG engineer who was actively involved in the tests, testified that he did not see any reason why the results from the 1999 tests should not have been included in the Topical Report (Gurevich deposition June 14, 2010, page 234).

The 1999 16" inch carbon steel pipe tests raise significant questions about the repeatability of the 1996 Alden tests, the accuracy of the Co curve in the Topical Report, and accuracy of the CROSSFLOW meter in general. The fact that they were run on piping that was more representative of the piping used in a power plant rather than on plastic pipe like the 1996 Alden tests was also significant. It is clear from the results of the 1999 Alden tests that contrary to the statement in the Topical Report, there was not close agreement between Equation 2-17 (the Co calculation) and the experimental data over a wide range of Reynolds Numbers providing confidence that the basis for the theoretical equation is well founded.

The Topical Report was submitted for NRC review in August 1999 with no mention of the performance of these tests nor are we aware of any subsequest disclosure to the NRC of this information. Further, Westinghouse did not resolve questions concerning the Byron and Braidwood discrepancies nor confirm or resolve the impact of noise on Crossflow accuracy. As was seen in 2003, Byron and Braidwood operated over their licensed power level for approximately 3 years while using Crossflow.[17] Item 29 is particularly illustrative in regard to the following statement made in March 2005 by a Westinghouse manager, "The issue is we cannot extrapolate lab test results at low Reynolds Numbers and low temperatures to actual plant conditions with the required uncertainty to achieve an overall uncertainty of less than .5%." Another significant document is Item 7 indicating knowledge in August 1999 concerning the lack of consistency of laboratory and field results and the need to develop a knowledge base that is robust enough to deal with real situations in the field. The Co curve was confirmed based on four data points (Alden Calibration Data) as shown in Figure 4.1 (page 4-7) of the Topical

[17] LER 454-2003-003-00, ML032810527, and LER 457/2003-002-00, ML032810226.

Report, none at Reynolds Numbers[18] comparable to actual plant feed water flow rates. Other points which did not fit the curve were rejected. However, as pointed out by Jaeger, a Westinghouse engineer, when he investigated the basis for rejecting the data points he could not find a supporting basis. He also stated that French, the Program Manager at that time, shared his views that the data points rejection could not be supported. Jaeger Deposition at pages 229-232. Moreover, it was recognized by French and others that the Co curve was not just a function of the Reynolds number. (Item 44A-July 10, 2005). Other supporting Items are 12, 15, 17, 27, 29 - 39, 43, 44, and 49 – 55.

Materiality:

The velocity profile correction factor was a key aspect to the accuracy claim for Crossflow because it was intended to account and correct for the differences between the Alden Laboratory test conditions and actual plant operating conditions. These differences included things such as temperature, pipe wall roughness, and Reynolds Number. If the Co value used in the Crossflow calibration is not valid, the device will read incorrectly which may potentially result in an overpower situation. If a reasonable agency reviewer was aware that the basis for the Co values provided in the Topical Report could not be substantiated from the information provided, then the device could not be approved for the accuracy claimed to support the power uprates.

Statement #3

The Topical Report submitted by Westinghouse in August 1999 stated on page 1-6 that, "Based on the above features (and others discussed later), the Crossflow UFM System is able to achieve an accuracy of 0.5% or better with a 95% confidence interval. When credit is taken for this feedwater flow measurement accuracy in a plant's thermal power calculation, it can easily be shown that the uncertainty of the calculation falls well below 1% with a 95% confidence interval." (emphasis added)

Westinghouse Knowledge of Inaccuracy:

Statement 3 was inaccurate because Westinghouse was not able to consistently demonstrate that the Crossflow UFM System could achieve the stated 0.5% accuracy at the required confidence level. Our view that the statement was inaccurate and known to Westinghouse is based on documents that are described in section C of Attachment 4.

Item 40 is particularly illustrative of the lack of confidence of Westinghouse in the Crossflow accuracy claim as evidenced by an email exchange between two senior Westinghouse managers where one states to the other in June 2005 in reference to some recently conducted Crossflow test results: "These new results really threw us for a loop. Our options are to continue trying to qualify the system, increase uncertainty and lose benefit or turn it off. No good ones." Other supporting Items are 1, 3, 6, 7, 20, 26, 28, 34, 35, 36, 43, 44, 45, 53,57B, 58, 63A, and 65.

Materiality:

[18] Reynolds Number is a number characterizing the relative turbulence and rate of flow of a fluid. It is a dimensionless function of density, viscosity, fluid velocity, and pipe diameter such that the higher the Reynolds Number the more turbulent and fast the flow.

The accuracy claim of the Crossflow UFM was vital to its use to justify increasing the power level of the nuclear power plants. The more precise the claim of accuracy by Westinghouse, the higher in power level a nuclear plant would be permitted to operate. If the accuracy claim for the Crossflow instrument could not be substantiated, the NRC would not have approved the applications from licensees requesting to raise the power level of their nuclear plants relying on the 0.5% Crossflow accuracy.

Statement #4

Beyond the examples cited above and the statements and claims presented in the Topical Report, Westinghouse continued to represent to the NRC that the Crossflow technology was sound and confirmed by laboratory data when they had ample evidence that it was not sound for the use and accuracy claimed. Westinghouse continued to deny to the NRC the very problems with Crossflow that it acknowledged internally.

Westinghouse Knowledge of Inaccuracy or Incompleteness:

Numerous statements that Westinghouse made to the NRC outside of the statements made in the Topical Report were either incomplete or inaccurate because they did not provide information that the NRC needed to make a decision on the adequacy or ongoing adequacy of the Topical Report, and they refused to acknowledge to the NRC the full extent of the performance shortcomings of the Crossflow system. Our view that the statements were inaccurate or incomplete is based on documents that are described in section D of Attachment 4.

Item 41 (June 10, 2005) provides one illustrative example in that a statement was made to the NRC in June 2005 (4 days after the discussion between the Westinghouse senior managers described above under Example 3, Item 40) downplaying the results of recent Crossflow tests. Another significant document is Item 25 (June 18, 2004) where Westinghouse, in a June 2004 letter to the NRC, notes that the "Crossflow Technology has a well founded theoretical basis supported by confirmatory laboratory test and in-plant data." This is inconsistent with information possessed by Westinghouse such as the 1999 16" pipe tests (Item 10) and the model testing described in Item 20, a May 2004 Westinghouse memo and the decision (Item 16A - February 5, 2004) to suspend sales of Crossflow systems until Westinghouse has a "thorough understanding of the root cause of the issues which recently developed at Exelon [Braidwood and Byron] and OPPD [Ft. Calhoun]." Other supporting Items are 12A, 13A, 21, 22, 23, 42, 56, 57, 57A, 57 C, and 59 – 63.

Jared Wermiel, Leader of the NRC UFM Task Force, as of July 2004, notes that despite the number of adverse operating plant experiences with Crossflow and internal Westinghouse questions about the validity of the original supporting basis for Crossflow use and accuracy as described in the Topical Report, Westinghouse persisted in meetings and telecons in its assertion that Crossflow if installed and operated in accordance with the Topical Report would meet the 0.5% accuracy claim.

Materiality:

A more complete ongoing understanding by the NRC of the technical shortcomings of the Crossflow system would have led to an earlier disapproval of the Topical Report.

EXPERT REPORT

8) **If Westinghouse had reason to know that its statements were inaccurate or incomplete (Question 7), did Westinghouse violate 10 CFR 50.5, the NRC Rule on deliberate misconduct?**

It is our opinion for the reasons given below that Westinghouse violated 10 CFR Part 50.5 on multiple occasions.

The NRC uses the term "willful" to embrace

> a spectrum of violations raging from deliberate intent to violate or falsify to and including careless disregard for requirements. Willfulness does not include acts which do not rise to the level of careless disregard, e.g., negligence or inadvertent clerical errors in a document submitted to the NRC.

Section IV.A.(4) of the NRC Enforcement Policy.[19] "Careless disregard" is in essence a reckless disregard or indifference to meeting requirements. See, section 6.1 of the NRC Enforcement Manual.[20]

A person, including a company, demonstrates careless disregard when information is provided to or withheld (incomplete) from the NRC without assuring the accuracy or completeness of the information when knowing that the information is material to the NRC. This is more than a simple error, misjudgment, miscalculation, ignorance, or confusion. In the context of this case, Westinghouse did not provide complete information when it knew or had reason to believe the information would be material to the NRC, e.g. the NRC would rely on this information when making its regulatory decision on the Topical Report application. This failure by Westinghouse demonstrated at least a careless disregard for the requirement to provide NRC complete and accurate information. NRC would consider such a failure to be willful. As noted above, willful violations are referred to the Department of Justice for consideration of criminal prosecution. This would include violations made with careless disregard for NRC requirements.

The documentary record provides a clear basis for concluding that Westinghouse was aware of significant information that would have been material to an NRC decision regarding the validity of the Topical Report and to the license amendments that it was evaluating on the basis of the Topical Report and that Westinghouse withheld such information from the NRC. Based on the comparison of the information that was possessed by Westinghouse, as evidenced by the discovery records, to the information Westinghouse provided the NRC, we conclude that Westinghouse's submittals of inaccurate and incomplete information exceeded careless disregard and, as described below, demonstrates sufficient willfulness based on our experience with 10 CFR 50.5, to conclude that Westinghouse violated 10 CFR 50.5.

The documents reviewed by Talisman present convincing evidence in our opinion that Westinghouse was aware that the information provided to the NRC was incomplete or inaccurate and that further effort on their part was necessary in order to support the original accuracy claim. Westinghouse was also aware in our view that the NRC was relying on this information for determining the acceptability and ongoing usage by NRC licensees of the Topical Report which

[19] http://www.nrc.gov/about-nrc/regulatory/enforcement/enforc-pol.pdf

[20] http://www.nrc.gov/about-nrc/regulatory/enforcement/guidance.html#manual

was an NRC acceptance of the use of this technology. Furthermore, NRC licensees were relying on this information to justify raising the power at which they operated their nuclear power plants.

The documentary record in our view provides clear evidence that Westinghouse was aware of shortcomings in the Crossflow technology that were not fully addressed or communicated to the NRC at the time of the submittal of the Topical Report. Additionally, the documentary record in our view provides clear evidence that Westinghouse was aware of significant shortcomings and problems with the Crossflow technology that would invalidate the accuracy assumptions made about this instrument in the Topical Report from the time before the Topical Report was approved by the NRC through the period of time that the NRC had communicated to Westinghouse significant doubt about the capability of Crossflow and was preparing to disapprove the Topical Report. To the extent that Westinghouse denies that its submissions and presentations to the NRC concealed material facts or included erroneous statements, Westinghouse in our view is refusing to recognize what was obvious.

In developing the response for this question we considered the following four time periods:

A. The period of time before and up to the NRC approval of the Crossflow Topical Report in March 2000.

B. The period of time following NRC approval of the Topical Report until the issuance of an NRC Task Force Report in July 2004.

C. The period of time from the issuance of the NRC Task Force report in July 2004 until the issuance of the NRC draft Safety Evaluation, dated March 13, 2007.

D. The period of time following issuance of the NRC draft Safety Evaluation (SE) dated March 13, 2007 through April 2007.

We used the analysis presented in the Document Summary found in Attachment 5 to assist us in formulating our response which is set out below. The Document Summary provides excerpts and/or summaries from documents relied on for these opinions and describes the relevancy of each document.

A) The period of time before and up to the NRC approval of the Crossflow Topical Report in March 2000 during which Westinghouse was aware of significant technical problems affecting the validity of the Crossflow accuracy claims but did not adequately address these problems or share them with the NRC.

The documents described in section A of Attachment 5 and testimony in depositions of Westinghouse personnel are relevant to this time period and support our findings.

Westinghouse was aware of concerns about flow profiles and its ability to get fully developed flow at 15 L/D as evidenced by Westinghouse statements prior to submitting the Topical Report to the NRC when one of their clients, Pacific Gas & Electric (PGE), in 1995 asked the Project Manager, Mr. French, questions about the 15 L/D assumption based on information in the RW Miller Flow Measuring Handbook. (Items 1 and 2 - October 26, 1995). In addition, in 1999 an engineering consulting company, MPR, on behalf of Vermont Yankee also took issue with the 15 L/D assumption (Item 3 - March 11, 1999). Westinghouse was aware of this concern as it

responded to Vermont Yankee stating it was relying on a prior Alden test (Item 3A- April 2, 1999). However, in June of 1999, Westinghouse learned that a more recent Alden test could not get fully developed flow until at least 30 to 100 L/D. (Item 4- June 21, 1999).

By at least by July 6, 1999, Westinghouse was aware of discrepancies in Crossflow readings between the Byron and Braidwood units despite their feedwater piping configurations being essentially the same and placement of the Crossflow meters at about 30 L/D, locations consistent with the Topical Report guidance. It was suspected that surface roughness may have biased the meters at those sites. (Item 4A – July 6, 1999). In addition, Westinghouse as a result of tests at the San Onofre Nuclear Generating Station (SONGS) also recognized that pipe surface effects may not have been fully accounted for. (Item 6- July 22, 1999.)

It is noteworthy that Brown, a Westinghouse Fellow Engineer, identified information that was available in the open literature prior to the submittal of the Topical Report that showed that

> 'fully developed' or 'stable' turbulent pipe flow may not be established for L/D>100 (refer to Klein, 'REVIEW: Turbulent Developing Pipe Flow J. Fluids Engineering, Vol.103, June 1981) downstream of a straight pipe entrance (let alone an elbow or tee). The effects of swirl downstream from an elbow in turbulent pipe flow may also persist for even longer distances (refer to Reader-Harris, 'The decay of swirl in a pipe', Int. J. heat and Fluid Flow, Vol. 15, June 1994).

(Item 27 – October 25, 2004), See also Item 46- November 29, 2005). For Westinghouse not to have identified this in light of the questions being raised by PGE and MPR as well as the results from the 1999 Alden tests demonstrates recklessness in preparation of submittals to the NRC amounting to at least careless disregard to the required need for accuracy and completeness for NRC submittals.

Westinghouse was also aware before it submitted the Topical Report to the NRC that field information it was receiving was different from the results being obtained in its laboratory testing. The data points from the June 1999 tests at Alden Labs of Crossflow readings in 16 inch steel pipe similar to what was installed at the Byron and Braidwood plants was substantially different from the original Alden Lab test results from 1996 on plastic pipe that formed a significant basis of the Crossflow Topical Report.[21]. (Letter from French- Item 10 March 26, 2000). It is also notable that French documented the results of the June 1999 tests in a draft letter to Jeff Drowley who was employed at Commonwealth Edison (licensee of Bryon and Braidwood) that did not support the original test results reported in the Topical Report 6 days after the Topical Report was approved by the NRC on March 20, 2000 (Item 10). Further, French provides in his deposition that during the July 1999 Westinghouse design review meeting on the Crossflow Topical Report Westinghouse engineers questioned the Ontario Hydro data (French Deposition, Vol. 1 at page 63) which appears to be the only point on the velocity profile correction curve for a high Reynolds number. The slides for this meeting stated the "need to have more rigorous documentation on Hydro lab and plant test results." (Item 5 – July 13, 1999). French stated during the deposition at 64, that to his knowledge, more rigorous documentation

[21] See page 22 of this report for a more detailed discussion of the performance of the June 1999 Alden Labs tests on 16" pipe.

was not provided. The slides for this meeting also indicate that there was need for more rigorous effort on deriving and controlling uncertainties and need to assemble a team to develop recommendations and action before any plant utilizes the Crossflow system for power uprates. (Item 5). French had no recollection as to whether such a team was created (French Deposition, Vol. 1 at page 78.)

Additional questions were raised because of issues identified in 1999 in the Peach Bottom and Pilgrim plant test results (Item 7B - January 3, 2000). Further, Crossflow readings between the Byron and Braidwood plants were different even though they were essentially the same design. Id. In 1999, the Crossflow measurements at Braidwood and Byron were not consistent with plant instrumentation and expectations (French Deposition, Vol.1 at page 104). French agreed during the deposition that these two plants before the Crossflows were installed were performing at exactly the same level and after the installation of the Crossflows differences popped up. French Deposition, Vol. 1, at 106, though the Crossflow installation was consistent with the Topical Report guidance. It was also recommended that "a 'time-out' ought to be taken in order to develop a knowledge base that is robust enough to deal with the real situations encountered in the field ... ." (emphasis added) (Note from Letendre to French and Doney-Item 7- August 18, 1999). The above recommendations and issues were apparently ignored by Westinghouse, and they proceed to submit the Topical Report and let NRC process it.

Westinghouse was aware that its Topical Report required fully developed flow and that that information was important to the NRC. In light of the above, Westinghouse also knew prior to the submittal of the Topical Report to the NRC in August 1999 that issues had been raised concerning the ability to obtain fully developed flow at 15 L/D. Westinghouse also knew that it had not informed the NRC about those concerns.

Additional questions arose in December 1999 while the Topical Report was under review by the NRC as noted by French in his deposition where he indicates that John Lareau, an expert on ultrasonics who was asked to review the AMAG data supporting Crossflow, had raised questions on the AMAG test method for accommodating pipe wall thickness effects in a memo to Rhonda Doney, Manager, Plant Systems (French Deposition, Vol. 3 at pages 20-23.) In this memo, Lareau says that "they [AMAG] tend to test until they get a value they like and then stop looking at any other possible sources of error." (Item 7A – December 22, 1999). Apparently these concerns were also ignored by Westinghouse and not reported to the NRC.

By February 21, 2000, Westinghouse knew that:

a) the National Research Council tests demonstrated that the correction factor due to upstream disturbances is flow dependent and that the Alden correlations downstream of an elbow have limitations that have not been determined by existing testing,

b) AMAG's Quality Assurance was suspect,

c) the set up procedures for the installation of equipment in the plants may be inconsistent,

d) there were questions concerning the calibration procedures including lack of traceability back to acceptable national standards,

e) there were questions about gain settings and the associated impact on uncertainty,

f) there were questions about the allowable operating range for a specific setup and when you are no longer getting the right answers. (Notes of Jaeger- Item 8 – February 21, 2000).

As to AMAG's quality assurance program, Kramarchyk, Crossflow Project Manager, noted to Doney that "AMAG's principal quality assurance staff person is a fine young man, albeit ineffective and utterly unqualified for such an important position." (Item 13- July 23, 2002)

A draft letter from Westinghouse to Commonwealth Edison dated March 26, 2000, states that the Alden test results (June 30-July 1, 1999) indicate that the flow straightener is having a significant effect on the velocity profile and that these effects are still present 41.3 and 51.3 pipe diameters (L/D) downstream of the reducer. (Letter from French- Item 10 March 26, 2000). Westinghouse had to have known of the 1999 test results prior to March 20, 2000, when NRC approved the Topical Report (Item 9) as well as before it submitted the Topical Report in August 1999.

Westinghouse knew during this period that NRC was relying on the information obtained from the 1996 Alden Lab test results that were described in the Topical Report as part of the basis for the regulatory decision about the Topical Report. Westinghouse also knew that there were issues being raised concerning those test results including information from the field and from testing being done by the National Research Council. However, this information was not provided to the NRC.

Consequently, it is our opinion that Westinghouse, by not informing the NRC of the conflicting information pertaining to the distance required to achieve fully developed flow and the effects of the inside surface of the pipe at SONGS, that was also suspected at Byron and Braidwood, deliberately provided incomplete information to the NRC thereby violating 10 CFR 50.5 when it provided the Topical Report to the NRC. In addition, it is our opinion that Westinghouse by not informing the NRC of information it knew after the submittal of its Topical Report deliberately withheld material information from the NRC making its submittal incomplete and inaccurate, thereby violating 10 CFR 50.5. Moreover, in our opinion, if the NRC had been aware of the information that Westinghouse had when the Topical Report was submitted, the NRC would not have approved the report, and it would have sought to have it withdrawn by Westinghouse until it had resolved the issues.

B) The period of time following NRC approval of the Topical Report until the issuance of an NRC Task Force Report in July 2004 during which Westinghouse was aware of significant problems with Crossflow which were not shared with the NRC

The documents described in section B of Attachment 5 and testimony in depositions of Westinghouse personnel are relevant to this time period and support our findings.

Following the NRC approval of the Topical Report, Westinghouse was aware of information that questioned the validity of its Topical report but did not correct the information it had provided the NRC. Westinghouse was aware in October 2001 that applications of the Crossflow meters identified risks with limited solutions including some with no known solution. (Item 12- October 24, 2001). (See also Item 11- October 16, 2001). These included:

1) Upstream flow disturbance,

2) Swirl (Pilgrim),

3) Acoustic Noise,

4) Poor signal Strength Due to Pipe Material (SONGS),

5) Poor Pipe Manufacture Quality (SONGS),

6) Signal Conditioning Unit (SCU) Calibration vs. Time Delay,

7) Hydrogen Injection (Pilgrim), and

8) Phantom Flow Profile Change (Salem)

This information was not provided to the NRC.

By letters dated July 25, 2002 and September 29, and 30, 2003, the licensees for the Hope Creek Plant[22] and the Byron[23] and Braidwood[24] Plants, respectively, submitted reports to the NRC indicating that they have exceeded their licensed power level while using the Crossflow to measure feedwater flowrate. In the case of Byron and Braidwood, the overpower condition apparently existed for over 3 years.

In December 2003, Westinghouse conducted an independent review of its Crossflow program which concluded that parameters affecting Crossflow readings (correlations underlying cross-correlation technology) may change for certain plant configurations and/or conditions, resulting in the potential for higher error (additional bias). The independent review recommendations included revising procedures for evaluating plant configuration impacts including the effects of swirl, inner surface condition, signal contamination, and reevaluation of potential failure mechanisms that could impact performance. (Item 15- December 18, 2003). Westinghouse management was so concerned with the results of this independent report that documented information and recommendations were not shared with the NRC. Doney, in a note to McInerney, Director of Systems and Safety Analysis, Liparulo, Vice President of Engineering Services, and others, stated, in respect to this independent report, that:

> There is no way we can say it's OK except for those items that need to be researched further. That will be political suicide for the NRC IC Branch considering they approved the technology and the ongoing investigation is challenging their credibility. We need to say Westinghouse says Crossflow is OK and there are several areas to further explore for continued refinement of the accuracy and longer term continued viability or something like that. If we can't say that, then we need to take the system out of service.
>
> We should approach the challenge as innocent until proven guilty, not vice versa, as people continue to learn and understand.
>
> .... We need to stay the course, persevere, and not let this report get issued, seen as a draft, until we are fully satisfied. The consequences of not waiting could have serious unforeseen effects on the delicate balance we are currently maintaining with the NRC and other utility customers. (emphasis added) (Item 14, December 4, 2003)

[22] LER 534/2002-005-00, ML022130420.

[23] LER 454-2003-003-00, ML032810527.

[24] LER 457/2003-002-00, ML032810226.

On February 5, 2004, an internal Westinghouse document (Items 17 & 18, February 5, 2004) contained a cautionary note to a draft InfoGram that questioned whether or not the existing Crossflow installation and the venturi correction it is determining is accurate and appropriate, or correctly calibrated. This document further stated that an alternate validation test (e.g. tracer or in-situ calibration) would have to be conducted to assure Crossflow performance is acceptable. The next day in a meeting with senior management these statements were retracted as the author appeared to have a "misunderstanding of all the technical issues". (Item 17A-February 5, 2004) Notwithstanding the stated reason for withdrawing the cautionary note, two days earlier, Westinghouse management (Turkowski) was directed that Crossflow system sales be halted until Westinghouse has "a thorough understanding of the root cause of the issues which recently developed at Exelon [Braidwood and Byron] and OPPD [Ft. Calhoun]." (Item 16A-February 5, 2004). As a result of unexpected deviations in operating performance during the period of August 2003 to February 2004, Westinghouse developed an action plan (Item 19-February 17, 2004) intended to address these unexpected problems that were not consistent with the conclusions in the Topical Report. Further problems arose when scale model testing of the Byron and Fort Calhoun plant specific arrangements indicated a potential data trend that could add a significant uncertainty to the Crossflow measurement (Item 20, May 10-11, 2004). As a result of this, Westinghouse concluded that the Crossflow system should not be put in service at Byron and Braidwood until the meters were properly baselined (Item 24-June 17, 2004). Westinghouse further stated that although the Crossflow meters at Byron and Braidwood were all installed 23 to 27 pipe diameters downstream of their respective 90 degree elbows per the Topical Report criteria, "unfortunately, the Topical Report was not explicit on the requirement to verify that this criterion to be met" and that the more rigorous installation process procedure in place at that time would have determined that the meter was being affected by upstream flow profile disturbance which would have prevented commissioning of the system until the baseline had been validated (Item 24).

Four Significant and Inconsistent Communications with NRC

During the time period that the above matters were occurring, Westinghouse had four significant communications with the NRC which provided information that was inconsistent with the items discussed above. Specifically:

1) Westinghouse in its April 3, 2002 letter provided materially inaccurate and incomplete misleading information by making highly confident statements about its technology (e.g., "The accuracy of the Crossflow meter can, therefore, easily be shown to be outstanding under operating conditions.) while internally discussing significant problems (Item 12A).

2) Westinghouse in a May 25, 2004, presentation to the NRC (Items 21, 22, and 23) provided materially inaccurate and incomplete misleading information to the NRC by not discussing the reservations and problems that Westinghouse was addressing internally (Items 14 and 15), by not providing test results that questioned the validity of the Topical Report (Item 20), and by concluding that there is "reasonable assurance that the Crossflow systems are operating properly" (Item 23).

3) Westinghouse in its June 18, 2004 letter (Item 25) provided materially inaccurate and incomplete misleading information by stating it continues to stand firmly behind the Crossflow

technology to perform its intended function(s) and persisted in its belief that the underlying Crossflow technology "has a well founded theoretical basis supported by confirmatory laboratory tests and in-plant data." (emphasis added). The statements in this letter are contradictory to the information known to Westinghouse at this time and are inaccurate. In fact, even Westinghouse was "troubled" by the statement that "In its June 18, 2004 letter, Westinghouse expressed confidence that reasonable assurance existed that current Crossflow installations in operation were performing properly, safely and within the licensing basis." (Item 26-October 15, 2004).

4) Westinghouse's attitude towards the accuracy and completeness of its communications to the NRC is also illustrated by its effort to refute a Caldon Topical Report, ER-262, Rev. 0, "Effects of Velocity Profile Changes Measured In-Plant On Feedwater Flow Measurement Systems," dated January 10, 2002, submitted to the NRC to show that clamp-on ultrasonic flow meters (those attached directly to the outside of the pipe wall) cannot meet high accuracy claims for feed water flow measurement because they are more sensitive to flow disturbances than in-line meters (Letter from W. Ruland, NRC to C. Hastings, Caldon, and H. Sepp, Westinghouse, dated January 28, 2003.) In response to the Caldon Topical Report, Westinghouse submitted Topical Report WCAP-15689, Rev. 0 and Rev. 1, "Evaluation of Transit-Time and Cross-Correlation Ultrasonic Flow Measurement Experience with Nuclear Plant Feedwater Flow Measurement," dated April 3, 2002 and September 12, 2002 respectively. Id. Westinghouse stated in this WCAP that;

> WEC/AMAG technical experts have completed a review of ER-262, to determine whether there is validity to Caldon's new concerns, which would be pertinent to the performance of the CROSSFLOW Ultrasonic Flowmeter System. This report documents the results of the WEC/AMAG technical review; which demonstrate that the conclusions presented in ER-262 regarding cross-correlation technology are not applicable to CROSSFLOW and that the CROSSFLOW technology is not subject to the specific technical issues associated with Caldon's transit-time flowmeter as documented in their report. (emphasis added) (Item 12A – April 3, & Item 13A- September 12, 2002).

In his November 11, 2009 deposition, French stated that there are no studies to support the claims in WCAP-15689 that Crossflow is less sensitive to flow disturbances than the transit time meter and admits that no specific analysis or team of experts as stated in WCAP-15689 was involved. It was essentially just his views (French deposition, Vol. 3 at pages 43, 46, & 50.). Molnar in his April 28, 2010 deposition at page 40 agreed that the Westinghouse response to ER-262 was wrong.

These communications from Westinghouse were consistent with the message from Westinghouse management as expressed in the Doney communication noted above (Item 14-December 4, 2003) where she stated the need for Westinghouse to address the issues with NRC as issues needing "refinement" and in essence not raise issues that challenge the basis of the Crossflow meter. "Approach this challenge as innocent until proven guilty, not vice versa." Id. The attitude at Westinghouse was to let NRC tell Westinghouse there is a problem. Of course, if NRC does not know the real facts, they will not recognize that there is a problem that Westinghouse is not addressing. As a result NRC was not informed of the material information that Westinghouse knew. Additional statements demonstrating the same view are from Westinghouse management such as a draft letter to the NRC "contains too much information"

and "the most significant topic raised was how to feature 'no problems' with current operating installations, given the validation findings at VY, Duane Arnold and Palisades." (Item 26 – October 15, 2004). In addition, Jared Wermiel, Chairman of the NRC UFM allegation task group recalls that despite adverse operating experience and questions about the validity of the original supporting basis for Crossflow use and accuracy as described in the Topical Report, Westinghouse persisted in meetings and phone calls in its assertion that Crossflow when installed and operated in accordance with the Topical Report would meet the 0.5% accuracy claim.

Consequently, it is our opinion that Westinghouse deliberately failed to correct the Topical Report and continued to deliberately mislead the NRC concerning the accuracy of its Topical Report in violation of 10 CFR 50.5 in each of these four sets of communications. Moreover, in our opinion, if the NRC had been aware of the information that Westinghouse had been withholding, the NRC would have moved more promptly to withdraw its approval of the Topical Report.

It is also our opinion, that if Westinghouse had not deliberately withheld this information, NRC would not have needed to wait until it received an allegation to begin reconsidering the approval of the Topical Report. Also, given the lack of a valid technical basis for the accuracy claim of the Crossflow instrument and the inaccuracies and incompleteness of the Topical Report, it would have been appropriate for Westinghouse to voluntarily withdraw the Topical Report.

C) The period of time from issuance of the NRC Task Force Report in July 2004 until the NRC issued in March 2007 a draft safety evaluation as the proposed basis for withdrawing the Topical Report during which time Westinghouse continued to represent the Crossflow technology to the NRC as consistent with its design and licensing basis (i.e., the Topical Report)

The documents described in section C of Attachment 5 are relevant to this time period and support our findings.

Following issuance of the NRC Crossflow Allegation Review Task Group Report in July 2004, Westinghouse continued to amass Crossflow testing data and other information that conflicted with the conclusions in the Topical Report. (Items 27 to 38, 40, 43 to 45, 46, 48, 49). Brown, a Westinghouse Fellow Engineer, in a summary of an October 25, 2004 telephone meeting expressed concerns that the noise issue at Byron, Braidwood, and Ft. Calhoun that led to difficulties with Crossflow has not been resolved. The 15 L/D guidance is also questioned. The note stated that that questions related to flow profile and turbulence should be addressed and have not received enough attention and "certainly not enough to satisfy the NRC and ACRS[25]." Item 27-Ocotber 2004). Jaeger, a Principal Engineer, stated that "there are already attempts underway to derive fudge factors to make the existing data fit the extrapolated Alden Co curve (already subject to suspect accuracy/system setup unknown accuracy variables) without regard to addressing/understanding all the variables that have affected the results." (Item 28- December 6, 2004). Despite the continuing questions on the adequacy of Crossflow at both the NRC and Westinghouse, the licensees for Calvert Cliffs and Ft. Calhoun submitted license amendment

[25] ACRS is the NRC's Advisory Committee for Reactor Safeguards

requests for MUR power uprates using Crossflow by letters dated January 31, 2005 and March 31, 2005, respectively.[26]

By March 2005, Westinghouse had recognized that it could not extrapolate lab test results at low Reynolds numbers and low temperatures to actual plant conditions with the required uncertainty to achieve an uncertainty of Crossflow of less than 0.5%. (Item 29 - March 12, 2005). The problem in extrapolating test results to actual plant conditions was demonstrated in "extensive testing." Westinghouse was apparently concerned with the test results and NRC reaction to them. McInerney, Director of Systems and Safety Analysis, stated that "any reasonable NRC review of the testing would only raise numberous[sic] questions for which we have no good answers." (Item29A- March 21, 2005). This indicates that Westinghouse did not have good answers to explain discrepancies between test results and the Topical Report. This may have also contributed to the reason for the lack of candor with the NRC in not disclosing test results that would be in conflict with the Topical Report. In April 2005 Westinghouse stated that the Topical Report Co equation assumes there is no change between hot and cold conditions even though the referenced textbooks indicate otherwise. (Item 30-April 14, 2005). Item 30 also stated that without verifying the Topical Report Co equation and associated uncertainty for each plant, "there is no basis for the continued use of Crossflow with respect to the Topical report claim." (emphasis added). Items 31, 32, 33, and 34 provide additional examples demonstrating Westinghouse's knowledge that the original basis for the Topical Report accuracy was invalid.

In an April 29, 2005 conference call Westinghouse noted that at this time it cannot state that all installations meet the uncertainty assigned in the Crossflow Topical report for the Co calibration curve uncertainty component. (Item 35-May 5, 2005). This is a significant statement given that this component of the Crossflow accuracy was a major part of the overall accuracy claim. In May, Westinghouse concluded that "present analysis methodologies and testing protocols of scale model laboratory tests do not provide defensible correction factors with reasonable uncertainties"; and that "calibration of the Crossflow meter performed at Alden laboratory in 1996 [which provided the basis for the Topical Report] is suspect due to the treatment (discarding) of some of the data points"; and that "equation 5-24 in the Topical Report is suspect due to high scatter and smoothing of data and filter application". (Item 36-May 9, 2005). In Item 37, draft May 17, 2005 meeting minutes, it is stated, "We found that the meter was not following the Co curve and these results were also confirmed by MHI. [This represents the fourth case where testing did not validate the data presented in the Topical Report. (see items 10, 20, and 36 for other examples).] This issue has a licensing implication, based on the reference to the Co curve in the Topical report." (emphasis added). However, this material information was not provided the NRC. Rather than letting NRC learn of this information so that it could decide whether the matter should be pursued, Gresham, Westinghouse Manager for Regulatory Compliance and Plant Licensing, took the view in Item 37A- May 25, 2005, that even if there were errors in the Topical Report, Westinghouse only had to make an immediate notification if we believe the actual accuracy of the system is greater than 0.5% or we don't know what the

[26] In order to address NRC questions on these requests, both licensees conducted tracer tests to confirm the feedwater flow measurements from Crossflow and conduct discussions with the NRC on these requests. The results of the tracer tests do not support the Crossflow readings and the license amendments requests for both plants were withdrawn in 2007 after the Crossflow Topical Report approval was withdrawn by the NRC.

accuracy is. Gresham also said in his deposition that a reason for not providing testing information to the NRC was that he did not want to cause confusion. Gresham Deposition at page 91.

In June 2005, in an e-mail exchange between Westinghouse managers, Gresham informed Liparulo, Vice President, Engineering Services, (Item 38 –June 3, 2005) that:

> We have recently completed the latest phase of tests on the Crossflow system which show results that appear to contradict the results of the original tests. These original test results are presented in the Crossflow Topical Report and are part of the basis for the NRC approval SER on the Crossflow system.
>
> The more recent test data, also performed at low Reynolds numbers, show results that do not agree with the original test data. Results of tests recently performed by MHI agree with Westinghouse/AMAG test results.
>
> These test data show a different behavior than the information in the Topical Report. This calls into question the basis for one component of the overall instrument uncertainty which is used to calculate the overall uncertainty for plant-specific applications.

Liparulo responds (Item 40-June 4, 2005) (referring to the 6/3/2005 email from Gresham)

> These new results really threw us for a loop. Our options are to continue trying to qualify the system, increase uncertainty and lose benefit or turn it off. No good ones.

At the same time, talking points were prepared for the NRC project manager describing the tests not as having invalidated the accuracy assumptions in the Topical report because the original testing to support the Topical Report did not test at operating conditions, but that

> These tests have shown that extrapolation of laboratory calibrations to field conditions is more difficult than originally envisioned.
>
> The new scale model extrapolation methodology test program produced results at low temperature, low Re[27] that do not agree with the tests originally run to support the Topical Report. This is not much of a concern since plants do not operate in this area and, again, the tests were not run at exactly the same conditions. (Item 39-June 3, 2005).

Importantly, Westinghouse did not provide the NRC the actual test data. Consistent with the talking points, Westinghouse on June 10, 2005 emailed the NRC project manager, Westinghouse stating:

> Results from this test program do not fully agree with the tests originally run (circa 1996) to support the Crossflow Topical Report. Specifically, as relates to the velocity flow profile correction factor correlation, Co, Westinghouse/AMAG believe that the new questions should not be a significant concern because plants do not operate in the low Re regime and the Scale Model Extrapolation Methodology Test Program was also not run in exactly the same manner as the earlier tests, thereby precluding a direct one-to-one comparison.

[27] Re is the abbreviation for Reynolds Number.

> The tests have also shown that extrapolation from low temperature/low Re laboratory conditions to high temperature/high Re plant operating conditions is more complex and difficult to achieve than originally envisioned. As we stated during our telephone conversation on Friday, while new questions have been raised, there is insufficient information available to conclude that information in the Crossflow Topical Report at high Reynolds Number plant operating conditions is invalidated. (Items 41 &42)

This communication provided materially inaccurate, incomplete, and misleading information to the NRC because the new information invalidated the accuracy assumptions in the Topical report, and the original testing in support of the Topical Report also did not test at operating plant conditions. In addition, this communication was materially incomplete and misleading because Westinghouse used extrapolation from low temperature/low Re laboratory conditions to high temperature/high Re plant operating conditions as a major part of the basis for determining Crossflow accuracy. Westinghouse did not disclose what it did know, which was:

- Recent test data invalidated the original accuracy claims
- The recent test data invalidated the Co curve assumptions in the Topical Report (Items 29A, 31, 32, 33, 34, and 37)
- The existing installations lacked a valid uncertainty analysis (Items , 20, 29, 30, 32, 33, 34, 35, 36, 38, and 40)

Furthermore while Westinghouse was telling NRC that results from the recent testing "did not fully agree" with the 1996 tests and that extrapolation of data from low temperature/low Re laboratory conditions to high temperature/high Re plant operating conditions "is more complex and difficult to achieve than originally envisioned", Westinghouse's June 10, 2005, Crossflow Generic Action Plan Composite Report, (Items 43 & 44) presented a more dire view. Specifically that

> the methods attempted to project the correction factors determined under the cold laboratory, low Reynolds number, conditions do not provide accuracies and uncertainty that support the commercial goals" (emphasis added) and
>
> The consensus is that although a couple of mathematical methods exist, the uncertainties associated with the methods are not in the range to support the Crossflow meters viable application for the Appendix K Uprate units. The high uncertainty (essentially un-definable) is due to engineering judgment needed to use the data to determine the correction factor. In addition, it will take considerable efforts, human resources and capital to develop methods to provide the desired level of uncertainty, if indeed methods can be developed. (emphasis added)

Westinghouse was also stating explicitly, internally by this time that the Co curve that was critical to the Crossflow accuracy claim was more than just a function of Reynolds number, which was contrary to what was claimed in the Topical Report as stated in Question #7, Statement #2 of this report. As Westinghouse key Crossflow engineer French notes, "there is more to defining Co than just Reynolds number." (Item 44A-July 10, 2006). This confirmed what they knew or should have known before the Topical Report was approved by the NRC. (Items 1, 2, and 10).

It is noteworthy that within Westinghouse, questions were being raised by at least one engineer as to whether, Westinghouse was sharing "good news" but withholding "bad news" from the NRC concerning Ft. Calhoun that could amount to a violation of deliberate misconduct. (Item 45-September 2, 2005). Westinghouse's response to that concern was that it discharged its 10 CFR 50.5 obligation by informing OPPD, the licensee for Ft. Calhoun. (Item 45A-September 9, 2005). However, Westinghouse, in our view, as a contractor to OPPD that supplied it the basis for an upgrade application, i.e. the Topical Report, had its own obligation to inform the NRC under 10 CFR 50.5 as we note in response to Question 6.

A root cause analysis for an overpower event at both of the Calvert Cliffs nuclear plants (Item 46-November 29, 2005) attributed the cause as the Crossflow Topical Report which, "...did not consider data indicating that piping/component configuration could produce flow distortions farther downstream than analyzed." This was further confirmation showing the assumption of fully developed flow at 15 L/D to be invalid. See also results from Wyle Laboratory testing that could not provide confirmation of the Topical report Co curve or the 15 L/D elbow position. (Item 48- December 8-9, 2005). In Item 49-January 11, 2006, a note from Molnar, a Westinghouse Senior Engineer, entitled, "(select one): 1) The Sky is Falling, The Sky is Falling 2) These are the Best of Times, These are the Worst of Times 3) What Me Worry 4) None of the Above" he states

> Preliminary hot tests conducted at the Wyle Laboratory appear to substantiate the results obtained from the 2005 ARL and NRC cold tests which were unable to demonstrate the accuracy of CROSSFLOW, as licensed in the approved Topical Report (CENPD-397-P-A, Rev. 1); current plants are licensed on the basis of using an inherent CROSSFLOW calibration (i.e., the Co curve). Westinghouse/AMAG believe that unconditional validation of the existing Co curve is not possible in the near term (and not at all with cold tests) nor at reasonable expense nor manpower resources.

Lurie, a Westinghouse Project Manager, on January 12, 2005 modified Molnar's note adding

> Further, if Westinghouse/AMAG continue to answer NRC questions regarding CROSSFLOW technology and the Topical Report, we expect that the NRC will request to review the laboratory data obtained in the 2005 cold tests. <u>This data, in the aggregate, does not support the Co curve uncertainty in the topical report</u>.
>
> (Item 49) (emphasis added).

This Wyle testing represents the fifth case where testing did not validate the data presented in the Topical Report (see items 10, 20, 36, 37 for other examples).

Jaeger, a Principal Engineer at Westinghouse, states on February 5, 2006 (Item 50) that

> ... however, we do know that it is no longer appropriate to use the profile correction as defined in the topical report without further validation. Since there is no longer a valid basis for the topical report profile correction, revised equations to reflect the effect of all involved variables have not been derived as of this time, and the fact that it is not possible to always correlate laboratory results to the specifics of the actual plant installation, the magnitude of the correction is unknown. It follows that the flow profile correction uncertainty has no valid basis.

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In an e-mail string in February 2006 involving Gresham, French, and Turkowski , French acknowledged that the key defining element against the Co curve was that Westinghouse was not able to reproduce the Co curve in either hot or cold laboratory tests and that the data points from the 1996 tests that fell close to the theoretical curve were picked arbitrarily while the rest of the data was ignored (Item 51 – February 13, 2006). In an email from Gresham to Eversly also in February 2006, Gresham stated, "As we discussed at your office, we don't feel we can defend the Co curve in the topical report based on all we have learned." (Item 52 – February 16, 2006). Molnar in his April 28, 2010 deposition at page 118 stated that he did not believe that Westinghouse ever told the NRC that it had concluded that it could no longer defend the Co curve set forth in the Topical Report. Westinghouse recognized it did not have enough data points to support the uncertainty of the Co curve (Item 53-March 14, 2006). By March 2006, Westinghouse knew a key employee, Jaeger, was of the view that Westinghouse had a need to share with the NRC the information about the cold and hot testing, specifically the results and trends seen from lab testing (Item 54-March 20, 2006).

In response to Jaeger's concern and reporting it to the NRC, Gresham explained in his deposition that the reason for not telling the NRC that the testing demonstrates that the Co curve was wrong, was that Westinghouse did not understand the test results and did not want to cause confusion with the NRC. Gresham Deposition at page 91. While it may be understandable from the Westinghouse position that it did not want to be embarrassed by this information by being asked questions before it had the answers, the result deprived the NRC and licensees of the ability to seek a better understanding and take compensatory actions to avoid compliance issues. In essence, Westinghouse deliberately decided what was best for the NRC to know, demonstrating a lack of candor that was not what the NRC expects from the regulated community based on the VEPCO decision. This attitude is further evidence of the willful actions of Westinghouse to deprive the NRC of complete and accurate information.

On March 29, 2006, Westinghouse met with the NRC. In its slides (Items 56 & 57-March 29, 2006) Westinghouse continued to state in slide # 6 that, "Operating plant experience continues to demonstrate performance of Crossflow, consistent with the design and licensing basis." The statement on slide #6 was materially inaccurate and incomplete in that the licensing basis (Topical Report) provided unequivocal claims, the most significant of which was the overall accuracy of the Crossflow instrument that could not be supported, a situation known internally to Westinghouse. In our view, Westinghouse persisted in its claim of Crossflow accuracy despite known evidence to the contrary.

Even a Westinghouse key Crossflow engineer, French, recognized that Westinghouse was misleading during the NRC March 29, 2006 meeting. A slide for that presentation stated, "For some non-standard installations, an in-situ calibration^{+} is required." (Item 56- March 29, 2006). However, French stated in a note to Turkowski and Gresham that "some" is misleading. He wrote "all" nonstandard installation will need an in-situ calibration and that based on what we know today, he believes that Westinghouse has to assume that there are "no standard installations" other than FT. Calhoun. He also stated that "the chance that there are some plants that can be classified as standard is close to zero … ." (Item 57A – April 28, 2006).

It is also noted that Slide #53 discussed the Westinghouse intention to update the Topical Report to remove outdated material; clarify statements based on experience and new information

gleaned from testing; incorporate new information not previously in the Topical Report, integrate information scattered among several Topical Reports; and add other new information not currently captured in the Topical Report.

In addition to the above, we note that in their letter to the NRC signed by J. Gresham dated June 2, 2006 (Item 57C); Westinghouse persisted in its defense of the Co curve and continued to state that when installed in a "stable/fully developed" flow location, Crossflow measurements were only a function of Reynolds number. These statements were clearly inconsistent with internal Westinghouse communications from Gresham to Eversley, Turkowski and Savage (Item 52- February 16, 2006) where he indicates that Westinghouse cannot defend the Co curve in the Topical Report based on all they have learned, and the T. Jaeger report (Item 30 - April 14, 2005) which indicates that the Crossflow algorithm for flow profile is based only on Reynolds number and the effects resulting from any other variable parameter remain unaccounted for thus causing extrapolation from lab conditions to plant conditions to be unsuccessful. We further note that the above letter indicates that improvements were made by Westinghouse to the installation, operation, monitoring and maintenance of Crossflow, yet none of these changes were documented in a revision to the approved Topical Report.

Based on the personal experience of Tom Martin (NRC, Director, Division of Safety Systems during 2006) it was his understanding at this time that Westinghouse was intending to revise the Topical Report to clarify the conditions under which the Crossflow could operate properly. Furthermore, he trusted at this time that Westinghouse, based on their communications with the NRC, had a technical basis for and confidence in the accuracy claims made in the Topical Report. However, based on the documents reviewed during discovery, it is clear that Westinghouse had neither a valid technical basis nor confidence in the Topical Report claims. This is evidence that the statements about updating or revising the Topical Report were misleading and inaccurate in that Westinghouse was unable to demonstrate in a technically valid manner that the Crossflow system could operate within the accuracy limits that would be necessary to support the requested upgrades. This is supported by an e-mail from Molnar to Lurie, Gresham, Turkowski, and others sent July 13, 2006 that two chapters of the Topical Report need to be thrown out in their entirety and all other chapters will need to "be heavily updated especially Section 5 on the uncertainty determination, this may even be a candidate for a complete rework)." (Item 58 - July 13, 2006). The e-mail attached a detail assessment of the continued validity of statements in the Topical Report "where the existing topical may be out-and-out wrong or where it needs clarification added to the existing write-up." (Item 58, July 13, 2006). In addition, operating plant problems continued to arise as the Kewaunee Plant licensee reported in a letter to the NRC dated February 19, 2007 that the potential for operation above its licensed power level existed due to larger potential uncertainties in Crossflow measurements.[28]

Consequently, in light of the above and the documents described in section C of Attachment 5, it is our opinion that Westinghouse violated 10 CFR 50.5 by deliberately failing to correct the Topical Report and continuing to deliberately mislead the NRC concerning the accuracy of its Topical Report in the June 10, 2005 e-mail to the NRC and during the March 29, 2006, NRC meeting. Moreover, in our opinion, if the NRC was aware of the information that Westinghouse

[28] LER 305/2007-002-00, ML070600140.

had been withholding, the NRC would have moved more promptly to withdraw its approval of the Topical Report.

We also note that during this time period licensees continued to submit license applications for MUR power upgrades relying on the Topical Report. For example, amendments referencing the Topical Report were submitted to the NRC for Calvert Cliffs and Ft. Calhoun on January 31, 2005 and March 31, 2005 respectively.[29] However, as noted above, during the time NRC was processing these amendments, Westinghouse recognized that it could not support the Co curve, which was a critical attribute of achieving the accuracy of the Crossflow instrument. As evidenced by an April 25, 2007 e-mail from Lurie (Item 63A – April 25, 2007) the licensees were not formally told of the true situation. In his e-mail he stated

> We have not told our customers, in writing, that there are any problems with the uncertainty calculations issued to them that support their implementation of CROSSFLOW and there by, operation consistent with their licensing basis requirements.

Clearly Westinghouse was fully aware that its Topical Report was being used in these amendments. Apparently, Westinghouse was attempting to maintain its story that the continuing tests it was doing was an effort to confirm the Co curve despite the evidence up to that point that this curve was not valid. In our view, Westinghouse's silence in providing the NRC what it actually knew amounted to deceiving the NRC. Consequently, in light of the above and the documents described in section C of Attachment 5, it is our opinion that Westinghouse violated 10 CFR 50.5 by deliberately failing to correct the Topical Report and continuing to mislead the NRC concerning the accuracy of its Topical Report.

D) Time period following issuance of the NRC draft Safety Evaluation (SE) dated March 13, 2007 through May 2007 during which Westinghouse continued to refer to the Crossflow technology as sound with shortcomings caused by plant specific application errors and were not forthcoming with problems known by them to exist in the Topical Report .

The documents described in section D of Attachment 5 are relevant to this time period and support our findings.

On March 13, 2007, NRC issued its draft safety evaluation (Item 58A) which concluded among other things that

> The NRC staff considers that the commissioning of CROSSFLOW as described in Topical Report CENPD-397-P, Revision-01-P is not valid based on calibration problems experienced with use of CROSSFLOW, the fact that neither fully-developed or stable flow have been adequately demonstrated to exist in plant feedwater systems over the range of flows and plant configurations assumed, the lack of adequate consideration and operational restrictions for a variety of factors that could impact the flow profile and its ultrasonic measurement, and the absence of a sound technical basis for transfer of the calibration data from a laboratory environment to a plant environment.

The letter identified four general weaknesses with the Topical Report:

[29] Calvert Cliffs MUR license amendment request is ML050380127 and the Ft. Calhoun MUR license amendment request is ML050940389.

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1. The assumption that laboratory calibration results are transferrable to an in-plant configuration without additional in-plant calibration.
2. The lack of periodic in-plant calibration using an instrument traceable to a national standard.
3. The lack of specific restrictions over a range of flows and plant configurations that define where the Crosssflow calibration can be considered valid.
4. Inadequate description of the installation and use of Crossflow consistent with the actual calibration and commissioning practices

NRC informed Westinghouse in the March 17th letter conveying the draft safety evaluation that based on its reassessment of the adequacy of the Topical Report; the NRC staff has determined that the staff's previous approval of this Topical Report should be suspended.

Westinghouse in an e-mail from Lurie stated that, "Laboratory Testing has shown that the calibration basis in every CROSSFLOW uncertainty calculation issued and which is documented in the Topical Report, can no longer be supported." (Item 63A -April 25, 2007). Westinghouse also recognized that neither ARL/PSU nor Wyle lab could get fully developed flow in classic sense after only 15 L/D. (Item 64 – May 10, 2007). In addition, ARL/PSU compared flow at 15L/D from an elbow and from 45L/D from a straightener and found that the Crossflow meters flow rate difference exceeded the stated accuracy of Crossflow (i.e. 0.5%). Id. On May 11, 2007 in a telecom note (Item 65), Westinghouse stated that

> The new SE [safety evaluation] will have implications for any new uncertainty calculations that Westinghouse issues; we can no longer use the laboratory calibration as a basis supporting the overall Crossflow uncertainty. We also noted that Westinghouse testing has led us to the same conclusion.

In a letter dated April 12, 2007, Westinghouse responded to the March 17th NRC letter. Despite the internal Westinghouse recognition of the Crossflow problems and the considerable evidence that Westinghouse had been trying unsuccessfully to resolve essentially the same issues identified by the NRC noted above, Westinghouse claimed it did not understand NRC's position. The Westinghouse response can be characterized as misleading, "playing dumb", and an apparent attempt to delay the NRC action to disapprove the Topical Report (See Items 59 through 63). These items provide examples of Westinghouse's comments where, in our view in light of the information that we have highlighted in Attachment 5, Westinghouse deliberately provided materially inaccurate and incomplete information misleading the NRC. For example, the Westinghouse statement in Item 59, that there was insufficient information provided in the safety evaluation to understand NRC's concerns and to develop a plan forward, was materially inaccurate and incomplete. The concerns outlined by the NRC in the draft Safety Evaluation were similar to the concerns being discussed internally by Westinghouse including the need for in-plant calibration (tracer testing), the need to control in-plant configurations, and the need to provide more detail in the Topical report about the installation and use of the system. From the documents in Attachment 5 and above in our response to Question 8, Westinghouse already had considerable knowledge about these issues and did not provide this information to the NRC.

Consequently, it is our opinion that Westinghouse violated 10 CFR 50.5 by deliberately providing inaccurate and incomplete information to the NRC when it submitted its April 17th letter to the NRC.

9) **What are your overall views of the significance of Westinghouse communications as to the NRC regulatory process?**

In responding to this question, we prepared Attachment 6 which provides a timeline that includes information communicated internally within Westinghouse, information made available to Westinghouse through test results, and information provided to the NRC either through reports or letters from Westinghouse or through reports or amendment requests from licensees. This provides an overall perspective of the information Westinghouse possessed and its communications with the NRC and licensees.

Based on our combined experience of more than 75 years in nuclear regulation, it is our view that Westinghouse's communications with the NRC were grossly inadequate to meet the needs of the NRC regulatory process.

The NRC regulatory process to a large degree is an audit process. It is dependent on licensees and its contractors providing complete and accurate information to the NRC and its licensees. The importance of candor and willfulness is expressed in Section IV.A.4 of the NRC Enforcement Policy:

> Willful violations are by definition of particular concern to the Commission because its regulatory program is based on licensees and their contractors, employees, and agents acting with integrity and communicating with candor. Willful violations cannot be tolerated by either the Commission or a licensee. (emphasis added) [30]

Other than the Thermal Science case, discussed above in the response to Question 6, we are not aware of any similar case where a contractor has repeatedly provided incomplete and inaccurate information.

Topical reports are important documents and play a key role in the overall NRC regulatory process as we noted in response to Questions 1- 4. Based on the internal documents that we reviewed, the pattern of deliberately withholding from the NRC information material to the NRC's staff reviews raises a serious question of the integrity and trustworthiness of the Westinghouse engineering organization and the key individuals involved. Deliberate misconduct raises a significant public health and safety concern even if the misconduct does not directly affect public health and safety because integrity and trustworthiness is the foundation of the regulatory process.

Consequently, our review of the documents in this case raises a question that goes beyond the communications related to the Crossflow device at issue here. It puts into question other Westinghouse's submittals on licensing matters to the NRC, as well as submittals to the NRC from licensees who rely on Westinghouse's engineering analyses and designs. Based on our collective experience we are not aware of any other example where a Topical Report was obtained and maintained based on the willful submission of inaccurate and incomplete

[30] See footnote 13.

information as demonstrated here. The issues raised here are similar to those in the Thermal Science case where the NRC stated:

> Violations involving multiple instances, in which a vendor deliberately provides inaccurate and/or incomplete information related to the performance and quality of its important-to-safety products, constitute a very significant regulatory concern, are wholly unacceptable, and will not be tolerated. These violations are further aggravated because they were committed in the context of an ongoing NRC investigation into concerns about the quality and performance of Thermo-Lag products with significant implications regarding the compliance of a substantial number of nuclear power plant licensees with the Commission's regulations.[31]

10) **Was Westinghouse's conduct the cause of the long delay in the NRC investigation of the adequacy of the Topical Report and was the timing of the final NRC resolution within Westinghouse's control?**

Yes. Based on involvement of Mr. Martin and Mr. Wermiel who were directly and significantly involved in the NRC actions related to these events, the focus of the NRC response to the Crossflow accuracy issues was directed at reconciling the conflict between the problems being reported by licensees and the Westinghouse ongoing position that can be typified by the following statements (Item 21, dated May 25, 2004).

> "Westinghouse/AMAG stand firmly behind the Crossflow UFM System and its ability to deliver its intended design function of providing highly accurate feedwater flow measurement."
>
> "Crossflow is based upon a well founded theoretical basis and is supported by confirmatory laboratory and in-plant data."

Even as late as April 2007, Westinghouse continued to feign ignorance to the NRC of the problems with Crossflow that its personnel were acknowledging to each other internally. (Items 59 – 63)

In our view, had the information discussed in this report regarding incomplete and inaccurate information on the Crossflow UFM accuracy been known by the NRC staff, the Topical Report approval would have been withdrawn much sooner than September 2007, and the staff would have issued a generic communication other than a Regulatory Issue Summary (which requires no licensee action) requesting actions by licensees using the Crossflow UFM. These actions would have included immediate removal of the device from service or a plant specific justification from the user for its continued use in determining feedwater flow rate.

[31] See footnote 10.

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Further, based on our direct experience in these type matters, there is no question in our view that the actions of Westinghouse described herein should be the subject to a wrongdoing investigation by the NRC Office of Investigation (OI). Because of the willfulness involved, the results of this type of OI investigation would likely result in not only a significant NRC regulatory enforcement action directed to Westinghouse but also a referral by the NRC Office of Investigations to the Department of Justice for potential criminal prosecution.

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James Lieberman
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Dated: July 19, 2010

Attachments:

1) Resume of Thomas Martin
2) Resume of Jared Wermiel
3) Resume of James Lieberman
4) Document Summary Organized by Statements in Question #7
5) Document Summary Organized Chronologically as described in Question #8
6) Timeline Demonstrating Recognition by Westinghouse of Issues with Topical Report